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	Page
Newton and the History of Optics ..	453
Journal of Scientific and Industrial Research	455
His Exalted Highness the Nizam, on Industrial Development	455
Research in Economic Science. By P. J. Thomas	456
Freedom of the Press	458
Letters to the Editor	459
Reviews	472
Newton, Mathematics and Ramanujan. By S. R. Ranganathan	474
Centenaries—	
Scheele, Carl Wilhelm (1742-1786) ..	476
Science Notes and News	476
Errata	482

NEWTON AND THE HISTORY OF OPTICS

THE 25th of December 1942 is the three-hundredth anniversary of the birth of Isaac Newton, discoverer of the law of universal gravitation and one of the greatest figures in the history of science. Newton's fame rests most securely on his great work *"Principia Mathematica Philosophiæ Naturalis"*. In this work Newton developed a system of mechanics on broad foundations and opened up many new fields of knowledge. In particular, he laid the basis of dynamical astronomy including especially planetary and lunar theory, the theory of the figure of the earth and the theory of the tides, as also of hydrodynamics and the theory of sound. The magnitude of the scientific achievements embodied in the *Principia* of Newton has been described by Lenard in the following words:—

> "If we open the book in order to examine it in detail, we are astonished, quite apart from the main discovery, by every part of it, and overwhelmed with admiration for the greatness, the extent, the power, as well as the fineness of structure, of what he erects upon the foundations given by Pythagoras, Archimedes, Leonardo, Stevin, and in particular Galileo and Huygens using the material afforded by Copernicus, Tycho and Kepler, and the tools provided by mathematicians from Euclid to Descartes, with very essential additions of his own. We are not less astonished and almost overwhelmed, by the countless number of single achievements, which, from whatever side the work is regarded and studied, are revealed to any one capable of comprehending them. The whole, when we consider the richness of its contents, the general and detailed form, and the impression it makes of towering greatness, can only be compared to a grand old Gothic cathedral: one stands in front of it filled with astonishment, absorbed in gazing at it, and without words to express one's impressions. Great cathedrals were built in numbers by the masters of Gothic, but among the works of men of science, Newton's *Principia* is unique of its kind."

The two years 1665 and 1666 which Newton spent at his country home of Woolsthorpe after taking his Bachelor's degree at Cambridge appear to have been the formative period of his youthful genius. To these two years have been traced back his fundamental discovery of the spectral character of white light, his invention of

the fluxional calculus, and his first conception of the universal law of gravitation. The recognition of Newton's transcendent abilities fortunately also came quickly, for in 1669 when he was only twenty-seven years of age, he was called to the Lucasian Professorship of Mathematics at Cambridge. In the years that followed and which were passed quietly at Cambridge, Newton published much of his work on optics and developed his thoughts on gravitation. The writing of the *Principia* was completed in 1684 and the work appeared in print in 1686. Newton's major scientific activities practically terminated in 1692. The later years of his life were spent in London in the discharge of his official duties as Warden and later as Master of the Mint. He was President of the Royal Society of London from 1703 till his death on the 20th of March 1727. Newton was buried in Westminster Abbey.

While Newton appears as a mathematical philosopher in his *Principia*, he is essentially the practical experimentalist and observer in his optical investigations which had as their starting point his desire to construct improved forms of astronomical telescope. Newton's approach to the subject is clearly stated in the opening words of the first book of his *Optics* which disclaim any desire to explain the properties of light by the aid of hypotheses. The reprint of the fourth and final edition of the book issued in 1931 makes Newton's work on the subject conveniently accessible to readers of the present day. The first book in the treatise sets out in full detail his observations on the spectral composition of white light and its consequences. The second book deals with the colours of thin and thick plates and their interpretation. The third book contains some evidently incomplete observations on what we would to-day call the diffraction of light by obstacles and narrow slits. The work terminates with the famous queries, thirty-one in all, in which Newton wrote down his thoughts on a wide range of topics.

As is well known, Newton favoured a corpuscular view of the nature of light. Indeed, he made it quite clear in his treatise that he rejected the wave-concepts of light advanced by Robert Hooke in his *Micrographia* (1665–67) and by Christian Huygens in his celebrated *Traite de la Lumiere* (1690). As is also well known, this had unfortunate consequences for the progress of optical science, Newton's great authority having kept back the inevitable triumph of the wave-theory of light by well over a century. The specific objection raised by Newton to the wave-theory of light in his query 28, namely that light does not bend into the region of shadow of an obstacle, was clearly based on an incomplete knowledge of the facts. This would, no doubt, have become evident to Newton himself if he had continued the experiments described in the third part of his book and approached the subject with an open mind. There has been a tendency in recent times to find some support for Newton's attitude towards the wave-theory of light in the recent revival of corpuscular ideas and even to find in his hypothesis of "fits" of easy reflection and transmission, a resemblance to the ideas of the quantum mechanics. It is sufficient to remark that it is precisely the phenomena of the kind de-

scribed in the second and third books of Newton's optics that form the strongest bulwarks of the wave-theory of light, and that the corpuscular aspects of the behaviour of light do not enter in the interpretation of these phenomena. Indeed, it does not seem easy to discover any real justification for Newton's rejection of the ideas advanced by his contemporaries Hooke and Huygens in explanation of the facts of optics known in their day.

C. V. RAMAN.

JOURNAL OF SCIENTIFIC AND INDUSTRIAL RESEARCH

THE *Journal of Scientific and Industrial Research*, the first number of which has just appeared, "is intended to place before the scientists and the lay public the results of various researches carried on from time to time and to stimulate both the scientists and industrialists to further efforts in research on the one hand and the utilisation of research on the other". It will provide a vehicle for the publication of results of all the researches sponsored or undertaken by the Board of Scientific and Industrial Research and "induce *entrepreneurs* to invest in industrial ventures in the secure knowledge that scientific help will be available to them in the teething stages of their industry".

In this country, there has been so far no effective organisation intended to establish a close and sympathetic understanding between Science and Industry which is so essential for a rapid and balanced development of both these branches of human endeavour. We have every confidence that this journalistic enterprise, which is guided by an Editorial Board of distinguished scientists and industrialists in this country and piloted by an able, experienced and talented editor, will serve to fulfil this vital function. We wish to offer a hearty welcome to the Journal and wish it a long and bright career of useful service in the cause of Science and Industry.

HIS EXALTED HIGHNESS THE NIZAM, ON INDUSTRIAL DEVELOPMENT

IN the course of an important Address which H. E. H. the Nizam delivered on the occasion of the opening of the Fifth Hyderabad Industrial Exhibition, His Exalted Highness drew the attention of the audience to the fact that owing to the war, the import of certain kinds of goods had ceased; this had created opportunities for manufacturing these goods in India and develop local industries. He continued, "It is our duty to make the most of such opportunities to make our country self-sufficient, and promote its needs. It would be a good thing if every one were to resolve to supply his necessities of life from goods manufactured in the country and buy only those articles from outside which were not manufactured here. In fact, even as regards these latter he should consider why they should not be made in India. My Government are not unaware of the opportunities presented, due to the war, of establishing certain types of industry here. They are in fact, trying to absorb as much local raw produce as possible in local industries for the financial benefit not only of the manufacturers but also of poor cultivators, who grow this raw material and labourers who work in factories.

"The industrial history of every nation bears witness to the fact that only those countries have advanced which have taken advantage of their opportunities, while those who wasted their time in mere reflection and achieved nothing practical, have lost ground, and have been left behind in the race by other more enterprising nations." His Exalted Highness added that it was in the interest of, as well as the moral duty of capitalists to prepare schemes for the manufacture of goods in demand in India and seek facilities and advice from the Government. In this way they would be able to reduce unemployment.

RESEARCH IN ECONOMIC SCIENCE

BY

PROF. P. J. THOMAS

(*University of Madras*)

RESEARCH in Economics is fundamentally different from research in the physical sciences. Being concerned with inanimate nature, the physical sciences deal with problems which are fairly common the world over, and therefore research in those sciences wherever conducted has a world-wide interest and goes into the world pool. But Economics is concerned with human beings, who, thanks to the free will with which they are endowed and also to racial and climatic differences, have developed institutions varying from country to country, and therefore the problems before economists in each country differ to a large extent. In the last hundred years, Western Europe and North America have developed a predominantly industrial civilization, and the economists in that part of the world have evolved a science of economics deduced from the facts obtaining there. Asia has indeed been greatly influenced by such developments in the West, but till lately the result has been that Asiatic economy had to adjust itself on a complementary relationship with the Western. While the West by utilising the remarkable technological advance in the 150 years has become the world's manufacturer, the more backward countries in Asia and America grow the raw materials and foodstuffs needed to feed the mills of the West and the men that work in them. There are also fundamental differences not only in economic but in social life between the West and East. All this has made the economic problems in India very different from those of the West, and economists in this country are concerned primarily with those problems.

There is indeed a substratum of theory which forms the core of economic science and which is of universal validity. The central point of this theory is value and exchange. Formerly this theory was formulated as rough hypotheses or generalizations and did not claim any great precision. Attempts have lately been made to formulate this theory more precisely by using mathematical tools and technique. In the first flush of enthusiasm, some thinkers claimed that with the help of such tools, a new positive science of economics with no relation to practical policy could be built up. While this claim has proved too optimistic, it must be admitted that the application of mathematical methods, especially statistics, has made the study of practical problems more precise, and has enabled economists to help more effectively in the formulation of public policy. The old Political Economy which was a compound of science and art has thus given birth to econometrics, a comparatively more accurate science using mathematical tools and building conclusions on the basis of the statistical measurement of economic phenomena. The new science bases itself upon facts and therefore the collection of statistics is of great importance. The old style of economic writing, consisting mainly of vague generalizations, is now at a discount. This has opened to the earnest student a new vista of advanced research. Economics has also become fruit-bearing in a more real sense that formerly, and a science of economic engineering is now growing. This has also facilitated the work of Government authorities in that their policies could be more carefully laid down, and pursued more systematically, watching the results periodically by means of statistical measurement. Economics is thus coming into its own, and this has enabled economists to be of greater use to their fellowmen. It is now possible for them to help substantially towards what Dr. Marshall considered as the supreme goal of economic studies—the eradication of poverty.

But in India there are great difficulties in carrying out such econometric studies. Firstly, we have not enough statistical data regarding our economic phenomena; nor are the available data of any high degree of accuracy. Our figures of external trade are perhaps the most accurate, but we have no data regarding our large internal trade which must be at least fifteen times as large as our external trade. Our census gives figures of population, and even these have not lately been very accurate owing to the abnormal play of political considerations. The 1941 census was a great improvement on the previous censuses from the economic point of view, thanks to the scientific flaire of the Census Commissioner,

Mr. Yeatts; but the war having intervened, the tabulation of the occupational tables has been shelved, and only the bare facts of population increase are available to us. Statistics of production and national income are of great importance to the economist; but as things are, reliable figures cannot be had in India about either of these. It must be admitted that fairly accurate information regarding agricultural production, at any rate relating to the chief crops, is available, because such data happen to be important in this country for revenue purposes; in fact in regard to the chief commercial and food crops of India, our statistics can be compared with those available in the foremost countries of the West. But a large number of minor crops have been left out. As for industry, some statistics of production in establishments coming under the Factories Act are available, but the figures are not complete, and it is hoped that the Industrial Statistics Act lately passed by the Government of India will mark a great improvement. These establishments, however, employ only 1½ million labourers out of the 40 odd million industrial workers in India; and we have little information regarding the production of the numerous labouring population engaged in handicrafts. Much the largest of these handicrafts—the handweaving industry—was lately surveyed by a Committee of the Government of India; and having been in charge of that enquiry, I am able to say that information regarding an industry employing about four million people and supporting about ten millions is very insufficient. Prices and wages form a very important part of a country's statistics, and data regarding these must be continuous, if they are to be useful; but the existing information is very meagre and not suited for proper economic analysis. The collection of grain prices has always been the concern of the Government, especially in Provinces like Madras and Bombay where land revenue is periodically resettled; and it is a fact worth noting that in Madras we have an uninterrupted series of prices of food-grains from the year 1800 onwards. The price statistics of Government are indeed valuable, but unfortunately the prices taken have not been from the cultivator's end, and therefore their usefulness is marred. Regarding the part of the national income going to trade, transport and the numerous miscellaneous services—a considerable item in other countries—we have hardly any information.

The primary data available being so meagre, economic research is seriously handicapped; and in the result some students adopted the easier path of making generalizations regarding economic problems and thus lent themselves to the criticism of political prejudice. Others patiently took up the laborious task of collecting primary data by means of economic surveys of village and urban conditions. Dr. Slater in Madras, Dr. Mann in Bombay and Mr. Jack in Bengal did pioneering work in this line and this has been followed up by Indian workers all over the country and in some Provinces by official Boards of Economic Enquiry. In Madras, we have resurveyed, after 20 years, the villages originally surveyed under Dr. Slater, and have analysed from the results the trends of change during the eventful years between the first survey (1917) and the second (1937). At any rate this will serve as a landmark for the economic historian. The critic cavilling at such studies on the ground that this is not economic theory must be told that without such minute collections of primary data economics will remain mere arm-chair theory and the economists cannot be helpful in directing public policy.

Such is the field before the research worker in economics, a field where laborious pioneering work is called for. The existing data are altogether inadequate and lacking in accuracy. Therefore the student in India will have to work harder than elsewhere till the factual foundations are properly laid. The facts of agriculture, industry, trade and transport must be collected and interpreted; none of these economic activities are in a very prosperous condition in India, owing largely to the prevalence of various evils of organization and functioning. Owing to such evils the national income of the country is at a rather low ebb, and consequently the standard of living of the masses is extremely low. The central problem of Indian economy is to increase production by tackling all these evils frontally and to see that the increased production is equitably distributed as between the different economic groups and individuals. A band of research workers is required if such a colossal task is to be carried out. There are also attractive avenues of research in economic history—nearly a virgin-field—which calls for workers. There are in India vast archives

still to be explored. Especially in Madras, the Government records are a marvellous collection dating right back to the 18th century, and we have here an immense field for fruitful research. Of course workers in this field may not have the limelight which those who investigate current problems sometimes receive, but their names may shine more brilliantly in the eyes of posterity.

There are also other impediments to the progress of research. One is that the degree courses in the universities do not give a proper equipment to the student, with the result that the post-graduate worker needs a longer period of training than in Western countries. A training in statistical methods is essential for research in economics, but no provision is made for this subject in the economic courses of most universities. Owing to the wide disparity in this country between emoluments in the civil service and other salaried posts, the great majority of bright students prefer the civil service and are lost to research. As every one knows, this is not true of England or America, where the best students cannot be thus enticed by the civil services. The university teacher in the West has a prestige which is denied to his confrere in India; nor are Government offices so ready here as in the West to give assistance to research workers. The British civil servants who came to India after training at Haileybury College under teachers like Robert Malthus a hundred years ago took great interest in the study of the economic problems of this country, but to-day the average civil servant in India confines himself to administrative duties, largely because the scope of such duties has greatly increased in recent times. The administrator should at least keep in touch with the studies bearing on his official duties; but one fears that there is an inclination on the part of the average administrator to take scant notice of the writings of academic workers, an inclination which is not in the best interests of the country. If it is admitted that advanced studies in Economics will throw some light on thorny questions of public policy, it stands to reason that every effort should be made by Government to encourage such studies and make them fruitful by rendering available to the advanced student all the data which are in Government's possession. Of course, the research worker too must deserve such help by making his studies objective and keeping clear of political and social prejudices. There is to-day in India a large scope for fruitful research in economics and it is hoped that such studies will make rapid strides forward in the years to come.

FREEDOM OF THE PRESS

A DISPUTE has recently arisen between members of the Association of Scientific Workers and the management of a London drug and chemical manufacturing firm. Scientific employees of the firm were asked to sign an additional "Condition of Employment" contract which included the clause: "I agree that I will not, without previous consent, publish books or articles, whether such be for remuneration or otherwise." Members of this firm had arranged to supply (for payment, we trust) a regular science feature to the local newspaper and they sought clarification of the new clause as it affected this. The management stated that consent would have to be obtained before publication. Moreover the employees were informed that it would be considered obligatory for them to submit other matters such as letters to *The Times* on non-scientific subjects, to the management before publication.

The A Sc.W. quite properly take the view that the clause referred to could be interpreted to mean that the employee gives up the right of publication of personal views and opinions upon matters quite unrelated to the business affairs of the company. In reply, the management have stated that they intend no infringement of the civil liberties of their employees unless their business interests are affected.

Important principles are involved, the main being the right of an employee, scientific or otherwise, to express his opinion on all subjects irrespective of the views and wishes of his employers. This perticular liberty must be guarded by all workers and we trust that the A Sc.W. will obtain the whole-hearted support of all professional orginizations in any steps it may take to ensure the freedom of the press.

Chemical Products, 1942, p. 57.

LETTERS TO THE EDITOR

	PAGE
Tactical Configurations and the Method of Symmetric Differences. By A. A. KRISHNASWAMI AYYANGAR	459
Photoelectric Efficiencies of Some Metals in the Soft X-Ray Region. By S. RAMACHANDRA RAO AND K. K. RAMAMURTI	460
Parachor and Latent Heat of Vaporization. By M. S. TELANG	461
Chromatographic Removal of the Growth-Promoting Factors from Natural Glycerides. By (MISS) V. DESOUUA AND M. Sreenivasaya	462
Vitamins, Minerals, Carbohydrates and Proteins in Tubers—I. By A. N. NAMJOSHI AND S. C. DEVADATTA ..	463
The Fatty Oil from the Seeds of Mallotus philippinensis, *Muel.* By S. V. PUNTAMBEKAR	464
The Nature and Fertilising Value of Phosphorus in Sewage. By K. G. JOSHI	465
Psilotum triquetrum *SW. at Lonavala, Bombay Presidency.* By T. S. MAHABALÉ AND G. S. DESHPANDE	466
Sex Dimorphism in Thyroglutus malayus. By M. B. LAL	467
A Note on the Prawn Fauna of Travancore. By S. NATARAJ	468
Preliminary Observations on Myxosporidia from Sharks. By S. B. SETNA ..	469
The Effect of Dams on the Migration of the Hilsa Fish in Indian Waters. By S. L. HORA	470

TACTICAL CONFIGURATIONS AND THE METHOD OF SYMMETRIC DIFFERENCES

A TACTICAL configuration may be defined as a finite aggregate of sets of elements combined according to given symmetrical principles. It is no wonder that such configurations occur almost everywhere in mathematics. Fisher and Yates[1] have now discovered a new use for them in the design of agricultural experiments. Various methods have been devised for the construction of particular types of configurations, centering round finite geometries, marks in the Galois field, multiply-transitive groups, and more recently the so-called symmetric differences. A little history of this last method is worth giving in this connection.

About 1931, when I struck upon a method of differences to set up finite geometries and discovered a few related theorems, I wrote to Professor Veblen, then of Princeton University, to give me some references. I quote below a few lines from his letter, dated October 7, 1931:

"With regard to the questions raised in your letter, I would say that I think you will find the theorem mentioned in your question number 2, in some of the books on Combinatorial Mathematics, for example, in Netto's book. At any rate I remember that I used the method of differences to set up finite spaces before I knew about the Galois field method.

"In general, I have no doubt that there are a great many finite spaces which are not obtainable by the use of Galois field method. One of my colleagues constructed examples of such spaces by laborious trial and error methods long ago. It would be interesting to get something systematic on this subject."

Not satisfied with the above vague reply, I announced my method of differences in a paper on "Finite Geometries" read before the Nineteenth Session of the Indian Science Congress, Bangalore, 1932. On page 105 of the Abstracts,[2] mention is made of the existence of modular sets of the type $(X_1, X_2, \ldots\ldots X_n)$: mod. $(n^2 - n + 1)$, where $X_r < X_{r+1}$ and the differences $X_r - X_s$, mod. $(n^2 - n + 1)$, are all distinct. Such sets may be briefly referred to as modular difference sets. For example, the set (1, 2, 4, 9, 13, 19); mod. 31 gives rise to a finite projective geometry of 31 points and 31 lines with six points in each line, and six lines through each point. Statistically, this represents a balanced incomplete block design of six experimental units, with thirty-one blocks, and thirty-one varieties.

In 1938, James Singer announced a method of obtaining modular difference sets from the

Galois field theory and utilised it to give a compact combinatorial representation of a plane finite projective geometry—just the same representation that I had given seven years previously and about which Veblen had remarked dubiously that it might be found in books on Combinatorial Analysis, like Netto's. Netto's book is unfortunately not accessible to me and in the recent articles of R. C. Bose, which refer to Netto's Combinatory Analysis,[4] Veblen's Finite Geometries and Singer's difference properties,[3] there is no indication of the method of differences being specifically employed in Netto's work.

A general method of discovering all possible difference sets is yet to be devised, while the problem whether every finite geometry or randomised block arrangement implies a modular difference set, is unsolved, though the converse is now known to be true. All the methods so far known about the construction of tactical configurations involve somewhere an element of guess work which seems to be unavoidable. However, the recent collections of examples of configurations due to Archibald, Fisher, Yates, Stevens, Bose and others provide some basis for the outlines of a general theory.

A. A. Krishnaswami Ayyangar.

Maharaja's College,
Mysore,
December 11, 1942.

[1] Fisher and Yates, "Statistical Tables for Biological, Agricultural and Medical Research," 1938.

[2] "Proceedings of the Nineteenth Indian Science Congress," Bangalore, 1932.

[3] Bose, R. C., *The Journal of the Indian Mathematical Society*, 1942, **6**, 1.

[4] —, *Annals of Eugenics*, 1939, **9**, 4.

PHOTOELECTRIC EFFICIENCIES OF SOME METALS IN THE SOFT X-RAY REGION

The photoelectric efficiencies of some metals in the soft X-ray region were studied by Davies[1] and Bandopadhyaya[2]. The latter author investigated the efficiencies of 11 elements for soft X-rays excited at 400 volts from a copper target. The order of efficiency was found to be very similar to that under ultra-violet light.

This resemblance between the photoelectric properties due to soft X-rays and ultra-violet light has also been suggested from the similarity in the absorption coefficients in the 500-volt soft X-ray region and in the ultra-violet region, found by Rudberg[3] and Partzsch and Hallwachs[4] respectively.

In the present investigation, this similarity has been extended by a study of the photoelectric efficiencies of Zn, Cd, Sn, Pb, Al, Mg, Ag, Ni, Co and Fe. The last few metals were studied so that the results may be compared with those of previous workers.

Millikan and Winchester[5] have studied the photoelectric efficiencies of some of these metals for ultra-violet light and gave the order Pb, Zn, Mg, Al, Fe, Ag and Ni.

Soft X-rays produced from a thoroughly outgassed nickel plate and freed from ions by a condenser arrangement, were allowed to fall on freshly degassed metal surfaces for the study of their photoelectric efficiencies. Four metals were used in one setting, these being arranged in the form of a lantern, with the degassing filament enclosed within the structure. The photoelectrons liberated were attracted to an external shield raised to a positive potential and the photoelectric current was measured by allowing it to leak through a high resistance, one end of the resistance being earthed and the other end being connected to a quadrant electrometer. The high resistance was made of a smoked quartz rod and had a resistance of about 10^{11} ohms. The experiments were carried out in high vacuum, the pressure inside the pyrex working tube being much lower than 10^{-6} mm. of mercury.

The metals could be arranged in the following order of decreasing photoelectric sensitivity:—Zn, Cd, Sn, Pb, Al, Mg, Ag, Ni, Co and Fe. This agrees well with the order given above by Millikan and Winchester[5] for some of these metals.

The following figures give the values of the work function of the metals, wherever these

are very reliable, taken from Hughes and Dubridge.[6]

Photoelectric work function (in volts).—Zn: 3·32-3·57, Pb :3·5-4·1, Al :2·5-3·6, Mg :3.4, Ag :4·73, Ni :5·01, Fe :4·72.

It is interesting to observe that the first four metals fall into one group and that the last three metals form another group. For the first group, the photoelectric sensitiveness is relatively large and the work function small. For the second group, the work function is comparatively large and the photoelectric efficiency correspondingly small. The photoelectric efficiency of a metallic element seems to depend not on its atomic number but on its work function.

Reference may be made to the changes of photoelectric sensitivity with change in the photoelectric threshold, observed with iron by Cardwell[7] using ultra-violet light and Rao and Sankarasubba Iyer[8] using soft X-rays.

Full details will be published elsewhere.

S. Ramachandra Rao.
K. K. Ramamurti.

Annamalai University,
Annamalainagar,
December 5, 1942.

[1] Davies, *Proc. Roy. Soc.*, A, 1928, **119**, 543.
[2] Bandopadhyaya, *Ibid.*, A, 1928, **120**, 46.
[3] Rudberg, *Ibid.*, A, 1928, **121**, 385.
[4] Partzsch & Hallwachs, *Ann. der. Phys*, 1913, **41**, 247.
[5] Millikan & Winchester, *Phil. Mag.*, 1907, **14**, 188.
[6] Hughes & Dubridge, *Photoelectric Phenomena*, 1932, 442.
[7] Cardwell, *Proc. Nat. Acad. Sci.*, 1928, **14**, 439; and 1929, **15**, 544.
[8] Rao & Sankarasubba Iyer, *Proc. Ind. Acad. Sci.*, A, 1941, **13**, 411.

PARACHOR AND LATENT HEAT OF VAPORIZATION

The latent heat of vaporization $l = \frac{5{\cdot}7\ T_b}{V_0 D_c}$, where T_b is the absolute boiling point, V_0 is the zero volume at the absolute zero and D_c is the critical density.[1] Further, $V_0 = \frac{[P]}{2{\cdot}873}$, where [P] is the parachor.[2] Since $V_0 = 0{\cdot}27\ V_c$,[3] $D_c = 0{\cdot}27\ D_0$, where D_0 is the density of the supercooled liquid at the absolute zero. Substituting the values of V_0 and D_c in the above equation,

$$l = 60{\cdot}7\ \frac{T_b}{[P]\ D_0}. \qquad \text{(i)}$$

The values of D_0 can be obtained from the equation

$$D_0 = \frac{D - d}{(1 - T_r)^{3/10}},$$

where D and d are the densities of the liquid and vapour respectively at the reduced temperature T_r.[4]

Substituting this value of D_0 in (i), $l = \frac{60{\cdot}7 T_b\ (1-T_r)^{3/10}}{[P]\ (D - d)}$. According to Guldberg-Guye law, $\frac{T_b}{T_c} = 0{\cdot}66$ for a large number of normal substances. Hence,

$$l = \frac{44\ T_b}{[P]\ D} \qquad \text{(i a)},$$

where D is the density of the liquid at its boiling point; d the density of the vapour is usually small and may be neglected. Evidently, (i) is more accurate than (i a), but the latter deals with a value of density which is more easily available.

Another relation between parachor and latent heat of vaporization has been deduced. Herz[5] has shown that the product $\frac{p_c V_c}{T_c}$ has the same numerical value as the Trouton constant $\frac{Ml}{T_b} = 21$, when the critical pressure p_c and the critical volume V_c are expressed in atmospheres and c.cs., respectively. The author has given a relation[6] $\frac{p_c\ [P]}{T_b} = 1952$ (cm.c.cs.). So,

$$0{\cdot}818\ \frac{p_c\ [P]}{T_b} = 21 \text{ (atm.c.cs.)}$$

Equating the two expressions, we have

$$Ml = \Delta H_m = 0{\cdot}818\ p_c\ [P], \qquad \text{(ii)}$$

where ΔH_m is the molal heat of vaporization.

The accompanying table incorporates the observed and calculated values of l for some normal liquids, by both the equations given above (i) & (ii). Associated liquids, however, do not obey these equations. The observed values of l are taken from literature.

Substance	I observed	I calculated by equation	
		(i)	(ii)
Carbon tetrachloride	46·8 cals.	46·6 cals.	52·6 cals.
Ether	84·5 ,,	90·5 ,,	83·2 ,,
Stannic chloride ..	30·5 ,,	31·3 ,,	31·7 ,,
Ethyl acetate ..	86·3 ,,	85·8 ,,	76·6 ,,
Benzene	95·4 ,,	92·1 ,,	103·7 ,,
Chlorobenzene ..	75·0 ,,	74·3 ,,	79·3 ,,

M. S. TELANG.

Department of Chemistry,
Ramnarain Ruia College,
Bombay,
November 17, 1942.

[1] Herz, *Z. anorg. Chem.*, 1926, **153**, 269-72.
[2] Sugden, *J. Chem. Soc.*, 1927, 1783.
[3] —, *Ibid.*, 1784.
[4] —, *Ibid.*, 1781.
[5] Herz, *Z. Electrochem.*, 1919, **25**, 321.
[6] Telang, *J. Indian Chem. Soc.*, 1942, **19**, 366.

CHROMATOGRAPHIC REMOVAL OF THE GROWTH-PROMOTING FACTORS FROM NATURAL GLYCERIDES

IN the course of our studies on the sterol requirements of the rice moth, *Corcyra cephalonica* Staint, it was considered necessary to employ a basal diet free from sterols but not free from glycerides. The preparation of such a diet offered difficulties because (1) all natural glycerides are associated with some type of sterol or another, (2) usual method of separating sterols from the oil (saponification) involves the destruction of the glyceride and often brings about a change in the structure of the unsaturated fatty acids, (3) there is no selective solvent by means of which a quantitative separation of the sterol could be effected either from the oil or from the diet. Both the sterol and the oil get simultaneously extracted to a greater or lesser extent, by all types of available solvents. An approach towards a solution of the problem is to be therefore sought either in finding a method by which the sterol could be quantitatively removed from the natural oil by a purely physical method, which will not bring about any change in the chemical composition of the glyceride, or in employing a synthetic glyceride as the source of fat in the basal diet.

Preliminary trials showed that chromatographic treatment of the natural glyceride would prove successful not only in securing an oil of sufficient purity (freedom from growth-promoting factors) but also in yielding a chromatographed column from which the sterols could be eluted by a suitable mixture of solvents. Brockmann's alumina (Merck) was found to be a satisfactory adsorbent for this purpose.

Groundnut oil (Syn.:—Arachis or peanut), which had been previously used in connection with our studies on insect nutrition, was found to exhibit varying degrees of growth-promoting activity depending upon the batch of the sample (obtained through the kind courtesy of the Vegetable Oil Products Company). During the process of refining, the oil, batches of which might vary in their initial sterol content, was not obviously deprived of its sterol to the same extent. A systematic purification of the groundnut oil was, therefore, undertaken with a view to obtain an oil free from growth-promoting sterol fractions. The oil diluted with an equal volume of petroleum ether (40°-60° C.), was passed through a previously prepared chromatographic column of alumina. The filtrate was passed a second time through another fresh column and the filtrate resulting from this, through a third column. Aliquots from the three filtrates together with the original solution of the oil in petroleum ether, were biologically assayed for their growth-promoting activity by employing the 16-day old larvæ of the rice moth. These larvæ had been fed on whole jowar for the first ten days and subsequently on chloroform-extracted jowar for the next six days. Chloroform-extracted jowar constituted the basal ration to which a given amount (4·28 per cent., corresponding to the percentage of chloroform extract of jowar) of each of the fractions was added and the diet

prepared. Insects in batches of five larvæ were weighed. The results are given in Table I.

TABLE I

Diets	0 days	13 days	21 days	Survivals	Recuperative Capacity of the Experimental Larvæ: Larvæ transferred on the 21st day to the following diets	35 days	44 days
A. Whole Jowar (*a*)	7·87	101·76	143·59	7 out of 7	Same Diet	All pupated (2 moths)	3 moths
(*b*)	6·79	65·74	143·07	6 „ „ 8	„ „	„	„
B. Chloroform-extracted Jowar (*a*)	8·01	38·41	62·83	8 „ „ 8	Whole Jowar	All pupated (2 moths)	6 moths
+ Groundnut Oil (*b*)	7·28	35·54	65·64	8 „ „ 8	Same Diet	All pupated	4 moths
C. Chloroform-extracted Jowar (*a*)	8·10	15·43	15·34	9 „ „ 9	Whole Jowar	96·86	All pupated
+ 1st Filtrate (*b*)	7·34	11·76	14·00	8 „ „ 8	Same Diet	23·63	23·11
D. Chloroform-extracted Jowar (*a*)	8·15	—	—	—	—	—	—
+ 3rd Filtrate (*b*)	7·70	12·11	10·94	6 „ „ 8	Groundnut Oil Diet	4·10	89·05
E. Chloroform-extracted Jowar (*a*)	8·64	10·68	8·96	4 „ „ 8	Whole Jowar	80·48	193·23
(*b*)	7·41	8·04	6·53	2 „ „ 8	—	—	—

After feeding the insects for twenty-one days on the respective diets, it was of interest to determine the recuperative power of these larvæ when they were transferred to diets containing the growth-promoting factors. On the twenty-first day of experiment, respective batches of larvæ were transferred to diets as indicated in Table I, and the insects weighed after known intervals of time.

It will be observed from Table I that (1) the sample of refined groundnut oil contains growth-promoting factors which are removed by successively chromatographing the oils through columns of alumina; this method of separation does not introduce any fundamental change in the chemical composition of the glyceride. (2) It has been further shown that the growth-promoting factors may be recovered from the chromatographed columns, in a potent condition, a fact which may prove extremely valuable to those interested in the preparation and purification of biologically active sterols. (3) The larvæ struggling on a sterol-free diet retain their recuperative power for comparatively long periods; they respond quickly and vigorously to additions of the elutate to their diet.

(MISS) V. DESOUZA.
M. SREENIVASAYA.

Indian Institute of Science,
Bangalore,
December 8, 1942.

VITAMINS, MINERALS, CARBOHYDRATES AND PROTEINS IN TUBERS—I

TUBERS form an important part of diet of the poorer class of people of this Province in particular. Considering their abundance, availability and storing capacity, it was thought desirable to determine their nutritional value by carrying out their chemical analyses. In the work presented here, analyses of tubers commonly available at Bombay were undertaken for vitamins B_1 and C, Minerals—phosphorus, calcium and iron, Carbohydrates—sugars, starch, etc., and proteins.

Vitamin B_1 was estimated from the water extract employing H. Tauber's method slightly modified in this laboratory. The estimation of vitamin C was carried out in trichloracetic

Results of 100 gm. of Edible Portion of Tuber

Common name	Botanical name	Moisture	Vitamin B_1 in Int. Units	Vitamin C in mgm.	P gm.	Ca gm.	Fe in mgm.	Protein gm.	Reducing Sugar gm.	Non-reducing Sugar gm.	Starch gm.	Cellulose and other undetermined constituents gm.
Colocasia	*Colocasia antiquorum* (Allahabad variety)	92·180	66·450	1·405	·060	·022	1·518	2·179	0·034	0·086	3·758	1·680
Elephant's foot	*Amorphophallus campanulatus* (Surat variety)	71·010	24·290	1·721	·031	·057	0·981	1·770	3·752	4·281	6·438	12·660
Potato	*Solanum tuberosum* (Talegaon variety)	78·400	22·250	13·660	·038	·081	0·672	1·530	0·000	0·340	18·003	1·607
Sweet Potato	*Ipomœa batatas* (Konkan variety)	71·298	18·940	17·403	·061	·024	0·773	1·105	0·430	0·480	22·100	4·501
Radish	*Raphanus sativus* (Large white variety)	94·630	71·770	16·780	·025	·045	0·359	0·537	1·717	1·230	0·188	1·628
Knol-kol	*Brassica oleracea* Caulorapa	90·170	83·210	23·346	·026	·030	0·498	2·825	1·892	1·430	0·522	3·105
Turnip	*Brassica campestris* (var.) *rapa*. White napiform variety	92·396	80·700	11·520	·037	·077	0·350	1·646	1·868	0·900	0·432	2·644
Beet Root	*Beta vulgaris*	86·570	76·408	26·210	·051	·182	0·953	1·806	1·020	7·852	0·246	2·272
Carrot	*Daucus cariota* (Orange conical variety)	81·150	64·913	2·389	·036	·082	1·320	0·948	6·757	4·231	0·113	6·682

acid extract, using the method adopted by L. J. Harris and S. N. Ray.[1] The ash of tubers was analysed for phosphorus, calcium, and iron using the methods developed by Brigg,[2] McCrudden,[3] and Kennedy[4] respectively. Carbohydrates were estimated, as in fruits, by N. D. Rege and S. C. Devadatta.[5] Subtracting the total amount of various constituents estimated from the dry weight, the amount of cellulose and other unestimated constituents present was calculated. Kjeldahl's method was adopted for the estimation of protein nitrogen. Full paper will be published elsewhere. The results recorded in the table indicate the mean of six careful estimations.

A. N. Namjoshi.
S. C. Devadatta.

Wilson College,
Bombay,
September 15, 1942.

[1] Harris & Ray, *Biochem. J.*, 1933, **27**, 303.
[2] Brigg, *J. Biol. Chem.*, 1922, **53**, 13.
[3] McCrudden, *Ibid.*, 1909, **7**, 83; 1911, **10**, 187.
[4] Kennedy, *Ibid.*, 1927, **74**, 385.
[5] Rege & Devadatta, *J. Univ. Bom.*, 1941, **10**, 3B, 74.

THE FATTY OIL FROM THE SEEDS OF *MALLOTUS PHILIPPINENSIS*, MUEL

The above oil has been prepared in this laboratory recently by extraction of the seeds collected locally with petroleum ether (B.P. = 40-60° C.) and the analytical data reported elsewhere.[1] When benzene is used for extraction, it extracts in addition to the oil, about 11 per cent. of a petroleum-ether insoluble resin. In a thin film, the oil dries in two

Constants	Author[1]	Singh and Saran[2]
Per cent. kernels in seeds	47	..
Per cent. oil in kernels	61 (Benzene)	48·8 (Benzene)
	50 (Petroleum ether)	..
Sp. Gr. of oil	0·8860/30° C. (Petroleum ether)	0·9333/33°C. (Benzene)
Refractive Index	1·4979/30° C.	1·5156/34°C.
Acid Value	19·0	11·3
Saponification Value	170·3	207·6
Iodine Value	183·2 (Hanus)	157·3
Acetyl Value	49·2	46·8
Unsaponifiable matter	1·8	1·9

hours and if left in a stoppered bottle for a few days, gets converted like tung oil into a

hard rubber-like mass. In view of a recent note[2] on the same oil by Singh and Saran, I give in the above table our several data for comparison and further study.

It is possible that the above differences in our data are due to the saponifiable resins that benzene extracts from the seeds.

S. V. PUNTAMBEKAR.

Forest Research Institute,
Dehra Dun,
September 6, 1942.

[1] *Forest Research in India*, Part I, 1940-41 and 1941-42.
[2] *Curr. Sci.*, 1942, **11**, 360.

THE NATURE AND FERTILISING VALUE OF PHOSPHORUS IN SEWAGE

ALTHOUGH the high phosphorus content of sewage is generally known, its fertilising value is ascribed only to its nitrogen and organic matter contents. The investigations of the author have shown that the phosphorus of sewage is not only largely available but also an important factor determining crop yield from certain types of soils. Thus, in a soil deficient in phosphoric acid [total P_2O_5, 0·037 per cent. and available P_2O_5 (Truog's method) 14 p.p.m.] application of sewage gave better response than an equivalent dosage of nitrogen in the form of ammonium sulphate, compost or seed cake. Application of phosphorus to this soil increased the yield as well as phosphorus content of the herbage. The following results will illustrate the above:

TABLE I

Nitrogen and phosphorus contents of sewage and activated sludge

	(Parts per 100,000)		
	Total N	N as nitrate	Total P_2O_5
Raw sewage	5·5	0·11	4·09
Wet activated sludge (with effluent)	18·4	0·72	12·70
Effluent	1·85	0·95	0·40

TABLE II

Response of tomato to different treatments

Treatments	Yield in gm. per pot
Tap water irrigation	131·7
Ammonium sulphate with tap water irrigation	174·5
Compost with tap water irrigation	227·6
Raw sewage irrigation	658·0
Raw sewage irrigation alternating with tap water	573·1
Effluent irrigation	315·6
Wet activated sludge irrigation	768·4

TABLE III

Response of Ragi (Eleusine coracana) *to different treatments*

Treatments	Initial Ht. in cm.	Growth in gm. 45 days	Dry matter in gm.	% P_2O_5 in dry matter
Tap water irrigation series				
Control (no manure)	17·8	20·9	0·9	0·25
75 gm. cake per pot	16·7	31·9	1·5	0·27
20 gm. super phos.	17·2	41·9	4·3	0·50
75 gm. cake + 20 gm. super phos.	17·7	67·5	25·6	1·24
60 gm. super phos.	16·4	51·3	5·9	1·10
Raw sewage irrigation series				
Raw sewage irrigation	16·3	54·3	9·6	0·32
75 gm. cake	24·3	62·3	21·6	0·37
60 gm. super phos.	15·8	75·2	23·4	1·62

Soils under sewage irrigation for over 20 years show accumulation of phosphoric acid in the surfaces 6" and to some extent in lower depths (Tables IV and V) and quite a large proportion of this is in available form.

TABLE IV

Percentages of total and available P_2O_5 in Bangalore sewage farm soils

Depths	Under sewage irrigation		Not under sewage	
	Total P_2O_5	Available P_2O_5	Total P_2O_5	Available P_2O_5
0" — 3"	0·130	0·062	0·083	0·025
3" — 6"	0·220	0·087	0·056	0·009
6" — 9"	0·070	0·018		
9" — 21"	0·017	0·0005	0·017	0·0005

TABLE V

Per cent. total and available P_2O_5 in Nagpur sewage farm soils

Depths	Under sewage irrigation		Not under sewage	
	Total P_2O_5	Available P_2O_5	Total P_2O_5	Available P_2O_5
0″ — 3″	0·226	0·100	0·065	0·023
3″ — 6″	0·146	0·065	0·063	0·024
6″ — 12″	0·079	0·025	0·049	0·015
12″ — 24″	0·059	0·018	0·038	0·010

From the fractionation of phosphorus of raw sewage and dried activated sludge given in Table VI, it will be seen that sewage contains a large proportion of water-soluble phosphorus and that the major portion of the total phosphorus is in inorganic form.

TABLE VI

Fractionation of phosphorus of sewage and sludge

Fractions	Raw sewage parts per 100,000	Dried sludge % of dry material
Total P_2O_5	1·75	2·16
Water-soluble P_2O_5	0·66	0·46
N/500 H_2SO_4 extractable P_2O_5	0·44*	0·24*
N/100 H_2SO_4 extractable P_2O_5	0·54*	0·54*
N–HCl extractable inorganic P_2O_5	0·94*	0·89*
N–HCl extractable organic P_2O_5	0·10	0·30
1% NaOH extractable organic P_2O_5	—	0·09
P_2O_5 in α–humus	—	0·10
α–humus	—	15·10

* excluding water soluble P_2O_5.

The enrichment of the surface layers of the sewage irrigated land is partly due to fixation of the water-soluble phosphorus and partly due to the addition of insoluble inorganic and organic phosphorus. After years of irrigation, it has been observed that soils under sewage irrigation show presence of water-soluble phosphates to a depth of 12″ or even more. But the surface 6″ layer soil contains a fairly large amount (1·5 to 7 p.p.m. in 1 : 5 water extract) and is fully saturated, as the soil cannot render any more water-soluble phosphates into insoluble forms. It is under these conditions that the water-soluble phosphate in sewage will penetrate to lower depths.

The details relating to the above and other relevant observations will be published elsewhere.

K. G. JOSHI.

Department of Biochemistry,
Indian Institute of Science,
Bangalore,
October 5, 1942.

PSILOTUM TRIQUETRUM SW. AT LONAVALA, BOMBAY PRESIDENCY

Psilotum triquetrum Sw. is one of the two species[1] of the genus widely distributed in the Malayan peninsula. This species is known to occur in many parts of India also but its distribution[2] seems to be discontinuous as the plants are often both local and rare. In the Bombay Presidency the species had been reported to occur at Sawantwadi by Dalgado[3] in 1896, and in the vicinity of Castle Rock and Karanzol (North Kanara) by one of us[4] in 1938.

FIG. 1

Psilotum triquetrum Sw. growing in the masses of aerial roots of *Ficus retusa*.

Last November, on a collecting trip to Lonavala a few plants of the same species

were observed to grow in the masses of aerial roots entwining the tree trunks of *Ficus retusa* growing at a distance of about half a mile from Lonavala on the way to Khandala by the old Khandala road, epiphytically, in contrast to their usual terrestrial habit noticeable at Castle Rock and Pachmari.[5] This constitutes a third record of the occurrence of this rare plant in the Bombay Presidency, and it extends the northerly limit of distribution of this species in the peninsular India considerably.

T. S. Mahabalé.
G. S. Deshpande.

Department of Biology,
Gujarat College,
Ahmedabad,
November 16, 1942.

[1] The other species *P. complanatum* Sw. (incl. *P. fiaccidum* Wall.) is not known to occur in India.

[2] For an account of the distribution of this species in India see Raizada, M. B., *Indian Forester*, 1935, **61**, 654–58.

[3] Dalgado, D. G., *Journ. Bom. Nat. Hist. Soc.*, 1896, **7**, 544.

[4] Mahabalé, T. S., *Journ. Bom. Univ.*, 1938, **6**, 62–75.

[5] In the forests in Shimoga District (Mysore State), however, the species is known to be both terrestrial and epiphytic in habit.

SEX DIMORPHISM IN *THYROGLUTUS MALAYUS*

Thyroglutus malayus is the largest millipede which occurs in and around Lucknow. The specimens vary from dusky red to light vermillion in colour. They are essentially terrestrial animals living in moist places concealed beneath stones or bark of decaying timber or amongst rich humus soil and feeding on decaying vegetable matter. *Thyroglutus* has an elongated cylindrical body—the length varies from about 3·00 cm. to 4·5 cm. The body is divided into a large number of segments varying between 58 to 63. The body of the millipede is divisible into three main parts, *viz.*, head, thorax and abdomen. The thorax lies immediately behind the head and is composed of four segments. Each segment is a complete ring of hard and brittle chitin. The thorax is distinguished from the abdomen by the fact that the first three segments of the thorax bear a single pair of legs and that the fourth thoracic segment is apodal. The second segment bears the generative openings besides the single pair of legs. In the thorax there is no trace of diplopody, a feature so characteristic of the abdominal region as to give the name "Diplopoda" to the whole group of millipedes.

In the case of millipedes the males can usually be distinguished from the females by the differences in size, *e.g.*, in *Strongylosoma contortipes* (which is very common in Lucknow) the males are thinner and smaller in size than the females upon which they are usually seen *riding* during the breeding period. The females are much stouter and carry the males on their back over long distances. Similarly in another local millipede *Orthomorpha modestina* there are clear differences in size between the males and the females. In the case of *Thyroglutus malayus*, however, the sizes of the males and the females vary considerably and the males may be sometimes larger than the females. But even in these cases the sex can be easily ascertained by certain external characters. Four such main characters may be mentioned, *viz.*, the nature of *Collum*, the condition of the post-thoracic segments and the variation in the second and seventh segments.

The first thoracic segment, which is broad and situated next to the head is known as the *Collum*. It is an incomplete ring as it is only the dorsal arch or scutum of a normal segment. A pair of legs is attached to the soft ventral portion of this segment. The shape and size of the *Collum* differs in the males and the females. In the females the *Collum* is comparatively larger than in the males. The lateral angle of the tergum of *Collum* is directed forwards in the males but is directed backwards in the females. The lateral sides of the *Collum* are more or less apical in the females while they are broad in the males.

The next three thoracic segments are normal both in the males and the females. But in the latter there is a narrowing of the circumference of the first three post-thoracic or

abdominal segments and then gradually the segments broaden again till the sixth abdominal segment is normal in circumference. Thus a narrow region, the so-called "Neck", is exhibited. In the males on the other hand there is no "Neck" as there is no narrowing of the segments in the body. The presence or absence of the "Neck" serves as a convenient distinguishing feature between the females and the males.

The second thoracic segment is smaller than the first but is complete and bears a single pair of legs behind which lies the generative opening. In the females the sterna are incompletely fused posteriorly and give rise to paired openings situated in between the second and third sterna and lying immediately behind the second pair of legs. These openings are placed on the paired oviducal projections. In the males the generative opening is single and median. It is a slit-like opening borne on an oval chitinous plate in the mid-ventral region of the second sternum.

The seventh body segment or the third abdominal segment is normal in the females, i.e., it bears the two pairs of legs; but in the males it shows certain modifications. The double pair of legs are entirely absent and instead there is present a single pair of modified gonopods. These gonopods which emerge from the sternal opening do not bear the male reproductive aperture but help in the process of copulation by keeping the oviducal apertures open.

M. B. Lal.

Department of Zoology,
Lucknow University,
October 24, 1942.

A NOTE ON THE PRAWN FAUNA OF TRAVANCORE

Panikkar (1937)[1] in an article entitled the 'Prawn Industry of the Malabar Coast', recorded seven common species of Penæid and five species of Palæmonid prawns from Travancore, and suggested that "it is probable that numerous other species recorded from other parts of India are also present here". This statement has been borne out by a recent survey of the Prawn Fauna of Travancore, conducted by me at the suggestion of Dr. C. C. John. The survey has not only brought to light many species unrecorded from this area, but has also proved that a few of the species regarded as 'common species' by Panikkar are either very rare or totally absent. Panikkar regards *M. lysianassa* as a common species, whereas I have not come across even a single specimen of this species in Travancore waters during the three years of my investigation. Further I have not been able to collect *P. scabriculus* recorded by Panikkar.

With Burkenroad's (1934)[2] revision of the genera *Penæopsis* and *Metapenæus*, Panikkar's *Penæopsis* becomes *Metapenæus*. *M. dobsoni*

Family	Genus	Species
Penæidæ ..	Penæus	* *P. indicus* M. Edw. * *P. carinatus* Dana (de Man). * *P. monodon* Fabr. Alcock. † *P. canaliculatus* Oliv.
	Metapenæus	* *M. monoceros* (Fabr.) * *M. affinis* (M. Edw.) † *M. dobsoni* var. nov.
	Penæopsis (subg) Metapenæopsis	† *M. stridulans* Wood-Mason † *M. mogiensis* Rathbun
	Parapenæopsis	* *P. stylifera* (M. Edw.) † *P. maxillipedo* Alcock. † *P. uncta* Alcock.
Palæmonidæ	Palæmon	* *P. carcinus* Fabr. * *P. idæ* Heller. *P. dolychodactylus* Hilgendrof *P. sulcatus* Henderson and Matthai. † *P. dayanus* Henderson
	Palæmonetes	† *P. hornelli* Kemp.
Alpheidæ ..	Alpheus	† *A. malabaricus* Fabr. † *A. paludicola* Kemp.
Sergestidæ ..	Acetes	† *A. erythræus* Nobili. † *A. sibogæ* Hansen. † *A. dispar* Hansen. † *A. serrulatus* var. now.

* Common species.
† Recorded for the first time from Travancore.

described from Travancore, appears to be a new variety having a wide distribution both in the sea as well as in the lakes.

A list of prawns recorded from Travancore is given below:—

I wish to express my grateful thanks to Dr. C. C. John for all the help and guidance rendered during the investigation.

S. NATARAJ.

Marine Biological Laboratory,
University of Travancore,
Trivandrum,
November 27, 1942.

[1] *Journ. Bombay Nat. Hist. Soc.*, **39**, No. 2.
[2] *Bull. Bingham Oceanographic Coll.*, **4**, 7, 7.

PRELIMINARY OBSERVATIONS ON MYXOSPORIDIA FROM SHARKS

THE meagreness of our knowledge of myxosporidia is surprising despite the widespread occurrence of this group both in marine and fresh-water fishes. Myxosporidia, as is well known, are found mostly in the gall bladder of fishes, but they have also been observed in other organs, such as, testis, ovaries, urinary bladder, brain, etc. Very few species of Myxosporidia have been recorded in India and for such knowledge as we have of this group we are indebted mainly to the studies of Southwell (1915), Southwell and Prashad (1918 and 1933), Ray (1933), Ganapati (1936) and Chakravarty (1939 and 1941). Most of the species described by these workers are of fresh-water fish from Bengal. These workers have not, however, investigated the occurrence of the parasites in particular groups of fishes but described them as they have found them in certain fishes. In this respect their work differs from that of Kudo, in Japan, who investigated numerous species of both marine and fresh-water fishes; or from that of Davis in Florida, who worked on representative groups of both marine and fresh-water fishes of the Beaufort region in North Carolina (U.S.A.). Both Kudo and Davis investigated the ocurrence of the parasite in whole groups of fishes, and their investigations have thus added considerably to the literature on the subject.

The need for similar study of myxosporidia infection among our fishes has long been overdue and the present investigation, conducted by Miss S. D. Mistry, B.SC., which is confined to the Elasmobranchs (sharks, skates and rays) only, has accordingly been undertaken. In this preliminary conspectus of the work done, I desire to place on record a list of hosts examined and the parasites found in them for the first time in this country. The list does not, however, include a number of hosts which appeared to be free from infection. A special feature worthy of mention is that invariably more than one species of the parasite has been found infecting the same organ. Thus, the gall bladder of *Cestracion zygœna* was found to contain a large number of trophozoites and spores of three species of myxosporidia, while *Caracharinus limbatus* contained no fewer than five species. Another striking fact disclosed during the investigation seems to be that Elasmobranchs are infected exclusively by three genera of myxosporidia. The genera, in the order of frequency in which they are encountered, are Ceratomyxa, Chloromyxum and Leptotheca. The absence of any other genus of myxosporidia in this group is indeed remarkable in view of the fact that they feed on a large variety of marine fishes, which, in their turn, are infected by other genera of myxosporidia. The three genera referred to above seem to be specially characteristic of Elasmobranchs not only in India but also elsewhere in the world and seem to be most suited for life in them.

Kudo, in his "Studies on the Myxosporidia", published in 1919, includes all forms reported in the world till then. He has listed 223 fishes as hosts, of which 24 belong to the Elasmobranchs, including the genus Raja, which, however, is not represented in Bombay waters. Kudo's observations, also, support the view that the Elasmobranchs are specially infected by the three genera of parasites enumerated above. Kudo, however, adds a fourth genus,

namely, Myxidium, found in representatives of the family Rajidæ.

Several species representing the three genera are new, and a detailed description of these will soon be published.

Host	Number of species from each host	Genus	Seat of Infection
1. *Carcharinus pleurotænia*	1	Ceratomyxa	Gall bladder
2. *Cestracion blochii*	2	Ceratomyxa Chloromyxum	do
3. *Cestracion zygæna*	3	Ceratomyxa Ceratomyxa Chloromyxum	do
4. *Chiloscyllium griseum*	1	Chloromyxum	do
5. *Carcharinus menisorrah*	2	Ceratomyxa Ceratomyxa	do
6. *Carcharinus limbatus*	5	Leptotheca Chloromyxum Ceratomyxa Ceratomyxa Ceratomyxa	do
7. *Hemigaleus balfouri*	3	Ceratomyxa Ceratomyxa Chloromyxum	do
8. *Pristis cuspidatus*	2	Chloromyxum Ceratomyxa	do
9. *Rhynchobatus djeddensis*	2	Chloromyxum Ceratomyxa	do
10. *Scoliodon sorrakowah*	3	Chloromyxum Ceratomyxa Leptotheca	do Kidney
11. *Scoliodon* sp.	2	Chloromyxum Ceratomyxa	Gall bladder
12. *Scoliodon walbeehmi*	3	Ceratomyxa Ceratomyxa Chloromyxum	do
13. *Scoliodon palasorrah*	2	Ceratomyxa Chloromyxum	do
14. *Carcharinus bleekeri*	3	Ceratomyxa Ceratomyxa Chloromyxum	do
15. *Hypoprion macloti*	2	Ceratomyxa Ceratomyxa	do
16. *Carcharinus melanopterus*	2	Ceratomyxa Chloromyxum	do
17. *Trygon bleekeri*	1	Chloromyxum	do
18. *Rhynoptera javanica*	1	Chloromyxum	do

S. B. SETNA.

Fisheries Section,
Department of Industries,
Bombay,
November 23, 1942.

THE EFFECT OF DAMS ON THE MIGRATION OF THE HILSA FISH IN INDIAN WATERS

IN the October issue of *Current Science*,[1] Devanesen has done a great service by directing attention to the fact that the construction of weirs in the Godavari, the Kistna and the Cauvery rivers has reduced the spawning areas of the Hilsa fish with disastrous results to its fisheries in South India. His presumption that before the erection of dams "the spawning Hilsa had the whole run of the river excepting the upper reaches" is abundantly borne out by the fact that in the Ganges the young of Hilsa have been collected as high up as Allahabad[2] and the fish is known to ascend as far as Agra and Delhi. The reported destruction of Hilsa in roe in immense numbers below the first anicut by fishermen is to be greatly deprecated and certainly calls for some protective, legislative measures.

After discussing the futility of the existing fish-passes and the establishment of hatcheries for the resuscitation of the depleted rivers, Devanesen suggests that "prohibiting fishing within a five-mile (?) length of the river from the first weir, observing a closed season of a few weeks or restricting fishing below the first weir to three days in a week may produce a salutary effect on the Hilsa-fisheries". There can hardly be any two opinions regarding the utility of these measures and the beneficial effects they are likely to have in adding to the stock of the existing population of Hilsa in the Indian waters.

The readers of *Current Science* will recall that a short time ago[3] the present writer in reviewing a symposium held in America, on 'Dams and the problems of migratory fishes', *inter alia* directed attention to similar problems in India. This subject was thoroughly discussed by the Fish Committee of the Imperial Council of Agricultural Research in October 1941, and on its recommendations the Governing Body of the Council requested "all provinces and State Governments to give due consideration to the fishery resources of the

water-ways, and that before starting construction of a dam or other types of structure proposed in any basin containing migratory fishes, surveys of fishery resources should be carried out by an expert with a view to making proposals to safeguard the interest of the majority of economically important fishes of the area. It was further recommended that as fish-ladders in some provinces had proved to be unsatisfactory, they should be replaced by more suitable devices to safeguard fish populations. Similar measures should also be introduced in other provinces where they did not already exist. It was also suggested that fishing should be prohibited within one mile of the lower reaches of a dam."

The Imperial Council of Agricultural Research has thus given a valuable lead and it is up to the various Governments to institute surveys of fishery resources by experts and if the existing fish-passes or fish-ladders are unsatisfactory they should replace them by more suitable structures. The prohibition of fishing within one mile of the lower reaches of a dam was just a suggestion, but in case it is found necessary to prohibit it over a greater area provision should be made for that in any protective measures that may be adopted.

Devanesen has shown that in view of the inability of Hilsa to leap in the air and of its habit of spawning in the lower and middle reaches of the rivers there is no case for fish-passes to be built for the migration of this fish. However, no experiments have yet been conducted on the type of suitable dams for different migratory fishes of India and in this connection it may be noted that in England, Wales and Scotland "the difficulties presented as regards the ascent of the breeding fish and the subsequent descent of the fry and kelts have now to some extent been met by the idea of a fish-pass with an adjustable feed from the reservoir, as has been adopted at Tongland (where the range of fluctuation in the top-water level does not exceed 41 ft.) and at the other impounding reservoirs on the same river system (the Kirkcubright Dee) which are comprised in the Galloway Power Scheme".[4]

There is no reason why experts in this country through extensive experimental studies should not be in a position to devise suitable measures to safeguard the interest of the majority of economically important fishes of the area likely to be effected by the construction of a dam.

Devanesen has also hinted on the futility of Hilsa hatcheries for the resuscitation of the South Indian rivers and his views are based on a long experience of experimental work conducted by the Madras Fisheries Department. For quite different reasons, I came to the conclusion that Hilsa hatcheries are not required for Bengal waters and I hope until the circumstances change no further costly experiments will be conducted in establishing hatcheries for this fish.

S. L. Hora.

Director of Fisheries,
Bengal,
1, Deodar Street,
Ballygunge, Calcutta,
November 20, 1942.

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[1] Devanesen, D. W., "Weirs in South India and their effect on the bionomics of the Hilsa in the South Indian rivers—The Godavari, the Kistna and the Cauvery," *Curr. Sci.*, 1942, **11**, 10, 398.

[2] Hora, S. L., "Dams and the problem of migratory fishes," *Curr. Sci.*, 1940, **9**, 9, 406, 407.

[3] —, "Life-history and wanderings of *Hilsa* in Bengal waters," *Journ. Roy. As. Soc. Bengal*, Science, 1940, **6**, 93-112.

[4] Anon, "Dams and the problem of migratory fishes," *Nature*, 1941, **147**, 487.

[See bibliography for earlier literature on the bionomics and fishery of the Hilsa fish.]

REVIEWS

Cathode Ray Tube and Its Applications (Second Edition). By G. Parr. (Chapman & Hall, London), 1941. Pp. viii + 180. Price 13*sh.* 6*d.*

Besides the thermionic valve, if one were to name an electrical apparatus of the greatest use alike for instructions, for research, or in industry, it would, undoubtedly be the Cathode Ray Tube. The above publication is a concise but very comprehensive and up-to-date treatment of this important and fast developing subject and would be useful both to the layman and to the expert. The contents have been classified in a rational and progressive manner and all the essential features in theory and practice, have been dealt with briefly without undue complication by higher mathematics. The chapters on 'Industrial and other Applications' and 'Television' are particularly interesting. A very recent application of the tube, however, as a coronavisor, which produces a picture of the solar prominences and corona for study at any time without the necessity for the occurrence of a solar eclipse, appears to have just missed the publication of the book. One of the most useful features of the book is the bibliography of 737 articles at the end, which forms an excellent compilation of references upto 1941. It would be of immense assistance to persons desiring to pursue further specific aspects of this apparatus. The printing and get-up of the book are entirely satisfactory in spite of its being a war-time publication.

Handbook of Physical Constants and Mathematical Tables. By T. N. Seshadri. (S. Viswanathan, 2|10, Post Office Street, Madras), 1942. Pp. 48. Price As. 12.

This handbook, or shall we say, pocket-book, is very similar to the well-known publications by J. M. Clark, both in format and the clear printing and get-up. It covers all the usual reference data and tables required for calculations in routine laboratory work. The book is free from printers' errors. Two textual errors, however, occur in page 8 and should be immediately corrected, *viz.*, 1 gallon of water weighs 10 lbs. *not* "apxly" but at 62° F. and 30" Hg. Also 1 Kilo-watt hour is *not* 1 B.T.U. of energy but 3413 B.T.U. of energy.

The book is priced rather high at 12 annas, but we hope that this is only a war-time price. It is an Indian publication deserving of full encouragement.

Plastics in Industry. (Second Edition). Revised by "Plastes". (Chapman and Hall, London), 1942. Pp. xiii + 248. Price 15*sh.*

This is a compendium on plastics with special reference to their present and potential uses in industry; the contents have a special appeal to the progressive industrialist who is on the look out for new materials of construction. The domain of plastics is rich in variety, quality and colour and the rapid advances made in the field have rendered it possible to find a plastic for almost every kind of manufacturing job. Diverse objects such as radio cabinets, milk bottles, bearings for metal rolling-mills, aeroplane parts, electrical accessories, furniture and fancy goods and coffins, have all been made from various types of plastics.

The ever-increasing scarcity of certain classes of metals created by the exigencies of war, has stimulated the necessity to find alternative sources of constructional materials; in this regard, plastics offer one of the most fruitful fields for exploitation. In a series of eighteen chapters, the author has clearly and successfully presented a picture of the nature, characteristics, types, specifications, moulding and fabrication techniques and applications of the several important varieties of plastics. The illustrations are beautiful and instructive; they enhance the value of the volume. It is a general treatise on plastics, which should interest not only the industrialist but also the general reader who may be interested in obtaining an idea of the nature and uses of plastics, the products of which are so familiar a feature of every office and household.

Practical Physics for Intermediate Students. By V. Venkata Rao, D. A. A. S. Narayana Rao and T. S. Narasimhamurthy. (The Authors, Vizianagram), 1942. Pp. 218. Price Rs. 2-4-0.

Many a student is more concerned with his practical record than with his experiments and tries to commit it to memory so that he may get through his practical examination. Books which are merely substitutes for practical records only abet this tendency and leave no scope for the student to dev-

elop the creative faculty in him. This defect is to be drastically remedied. It is, therefore, to be seriously considered whether it is desirable at all that a student should, for improving his scientific abilities, take help from such books.

The volume under review has a limited objective in view, *viz.*, to take the students of the Andhra University I.Sc. safely through the practical examination. The authors have spared no pains to meet these requirements. However, a little more care should have been bestowed on the diagrams in some of which the clamps and the corks are out of all proportion to the rest of the apparatus. In some places the word 'weight' has been used for the word 'mass'. The reviewer hopes that these will be taken into consideration by the authors, in any revised editions.

D. S. S.

Spectroscopy and Combustion Theory. By A. G. Gaydon (with a Foreword by Prof. A. C. Egerton). (Chapman and Hall, London), 1942. Pp. x + 191. Price 17*sh.* 6*d.*

The book deals with the contributions of spectroscopy to the theory of combustion. That it should appear in the midst of a devastating war is rather significant. Aerial bombardment as a weapon to exterminate cities has not been completely successful. Better knowledge of the mechanism of combustion will, of course, enable man to improve upon this weapon in future wars! It will also lead to more economical methods of utilizing fuel materials, the world supply of which may not be long maintained. Lastly, there is the potential gain of extension of knowledge and the satisfaction of having 'wrested' some more of Nature's secrets, consequences of which are not easy to foresee.

The spectroscopic approach to many problems is still in its beginnings. It is especially so in the case of problems of combustion because the processes here concerned involve radicals and molecules more than atoms; and molecular spectroscopy itself, is of comparatively recent growth. The book under review is an attempt "to collect together and discuss the results of recent research in the various ways in which spectroscopy has been applied to combustion problems". Naturally, in a subject like this which is still in the making, many conclusions are bound to be provisional and a certain amount of personal bias cannot be eliminated. In spite of these limitations, the author has certainly brought to bear upon the subject a broad, refreshing and stimulating outlook. The publication is a welcome addition to the not very extensive literature (specially in English) on molecular spectroscopy. The book, along with a modest spectroscopic laboratory, is what the reviewer would highly recommend to the various institutions which are interested in fuel technology in this country.

R. K. ASUNDI.

You and Your Radio. By Vepa V. Lakshmana Rao, B.E., D.I.C., A.M.I.R.E. (Madras Law Journal Press, Mylapore, Madras), 1942. Pp. xvii + 187. Price Rs. 3.

The "Radio Receiver" is now a definite item in the accoutrement of many Indian houses. It is widely used merely as a clever tool devised by the scientists for tapping messages passing through the "air" and emanating from various "Stations" and when it gets out of order, it has only to be packed up and sent to the nearest "repair shop" for reconditioning. But the human species is by nature curious and there are many who are eager to know, without going much into the details, something of the "innards" of their set and of how it works and how the messages are put over into the air from the various stations. The average school or college student can at best tell him something of the "lamps" used inside and a few other generalities but this is rarely satisfying. Mr. Vepa has now come forward to fill this need and he presents in a breezy conversational style an explanation of the whole organisation of "broadcasting" and of the several mysterious technical terms such as "fading", "skipping distance", etc., which are so commonly used by the technicians. The book covers a very wide range of topics, including interference suppression, what and when to tune?, radio-gramophone, batteries and their upkeep, radio relaying, types of radio licenses, rural broadcasting, etc.

It is therefore, the more to be regretted that such a book should be marred by the extreme crudity of some of the illustrating diagrams. We refer in particular, to those on pages 37, 85, 89, 118 and 129. It is hoped that by the time a next edition is called for the author will get ready a complete new set of carefully drawn diagrams to replace the present ones. With this improvement one can anticipate that the book will get increasingly popular. G.

NEWTON, MATHEMATICS AND RAMANUJAN

BY

RAO SAHIB S. R. RANGANATHAN, M.A., L.T., F.L.A.

(Librarian, Madras University Library, and Secretary, Madras Library Association)

SEPARATED by an interval of about two centuries and a half, the mathematical heritage of mankind was enriched by two remarkable men—Newton born in Britain, 25 December 1642, and Ramanujan born in India, 22 December 1887. They had just a little in common; but they differed widely in most matters—even in the force that pulled them to mathematics.

1. Dissimilarities

Newton spent his early years in fairly comfortable circumstances, in spite of his father dying before his birth and his mother remarrying before he was three; Ramanujan's parents, though both were living, could not keep him above want till he began to earn. Before entering adulthood, Newton had passed through the University of Cambridge, learned virtually all that could then be learnt in mathematics and contacted the eminent mathematicians and natural philosophers of his days, either as teachers or as friends; but till his twenty-fifth year Ramanujan could not come across any who would understand him or his language and still less teach him, nor could he finish the university course nor know the then state of mathematical knowledge. Notwithstanding his anxiety to avoid 'contention' of any kind, Newton's discoveries involved him in frequent and bitter controversies and much tension prevailed between him and his peers; it was, on the other hand, an atmosphere of uniform and spontaneous admiration, love and respect that surrounded Ramanujan after he was discovered. Newton was long-lived; Ramanujan died prematurely.

2. Similarities

And yet they had just a few things in common. Mathematics was the meeting ground of the two geniuses, though they approached it from different directions. Their life's work was done by the time they were thirty, though one lived for half a century thereafter and the other gave up his mortal coil almost immediately. Newton wrote down his results in diaries, letters and note-books, most of which are still preserved in some British libraries and had been all published in his own days though it was a job to make him release them for print; Ramanujan too wrote down his results systematically in a note-book which he left behind in England, where I was fortunate to pick it up in 1925 though it was in a tattered state; and it is now the most precious possession of the Madras University Library, still awaiting publication as a whole. The Royal Society elected both of them as its fellows before they passed thirty.

3. Integral Calculus

Newton's boyhood had been rich in hobbies of a mechanical sort like making kites, sundials and windmills. Kepler's *Optikas* is said to have been the first book to engage his serious thought. Consistently with this, one of the important books that Newton himself published was his *Opticks* (1704). He would grind lenses and if the telescope could not be made achromatic, he would invent a new type of telescope, the reflecting one. Consistently with this if a mathematical tool was wanting or defective, he would improvise a new tool or sharpen what existed. When his theory of gravitation led him to calculate the attraction of a sphere, which he could not do by the then known mathematical tools, he invented a new tool—the integral calculus. Particular problems of finding lengths, areas and volumes had been solved before him by special devices; but a general tool applicable to all similar problems was invented only by Newton and that because his preoccupations with his theory of gravitation needed it. The *Tractatus di quadratura curvarum* first appeared as an appendix to his *Opticks*.

4. Conics

The determination of a central orbit as a conic involved Newton in facing the problem of finding the conic when a focus and three other conditions or any other five conditions were given. These were fully investigated in the *Principia* (1687).

5. Problem of Three Bodies

The phenomenon of tides challenged Newton for an explanation on the basis of his theory of gravitation. While Proposition 66 of Book I and 24 and 26 of Book III of the *Principia* were turned on it directly, the foundations of the profound problem of three bodies were also laid incidentally.

Calculus of Variations

In considering the form of ships, Newton was obliged to determine the shape of bodies of revolution that will experience the least resistance when moved in the line of its axis. He improvised in 1686 a new tool to do this job and showed it to Fatio Duillier who published it in the pamphlet *Investigatie geometrica solidi rotundi in quod minima fiat resistantin* (1699). This tool, the calculus of variations, was lost sight of, until it was rediscovered by Lagrange in 1762.

Calculus of Finite Differences

Proposition 40 of Book III of the *Principia* is followed by Lemma 5 which gives a general solution of the problem: "To describe a geometrical curve which shall pass through any given points"—the fundamental proposition of the calculus of finite differences. *Methodus differentiates* (1711) which gives another solution of the same problem was first translated into English in the pages of the *Journal* of the Institute of Actuaries in 1918.

Cubics

The *Enumeratio linearum tertu ordinis* which appeared as an appendix to *Opticks* was the first systematic contribution to the theory of higher plane curves. 72 species of cubics were enumerated. As many propositions were without proof, this became one of the most commented of Newton's works. His method of classifying cubics appears to have inspired Waring to apply it to the quartic of which he obtained 84,551 species. To evaluate Newton's contribution to this field, we should remember that the modern tool of projective geometry had not yet been forged.

Calculus of Fluxions

The most discussed of Newton's tools from the point of view of priority of discovery is the calculus of fluxions. This again was forged to meet a definite situation in the determination of orbits. In fact he first invented the binomial theorem and then this calculus. The *Principia* had given its substance without the name in certain propositions of Book I. Evidently influenced by his dynamical interests, Newton regarded all variables as functions of time and all variation as primarily happening as time flows on. He, therefore, invented a calculus to determine the rate of change of any magnitude regarded as a function of time. These rates were called fluxions. They were with respect to time. The rate of change of a magnitude x with respect to another magnitude y he defined as the ratio of the fluxion of x to the fluxion of y. In spite of Newton's fluxional approach providing the beginner with an intuitive and familiar illustration of the concepts of calculus and in spite of time having been appropriately basic in the specific problem that led Newton to its discovery, it was soon felt that it was needless to drag in time where it was not concerned; and Leibnitz produced a calculus unobsessed by the spirit of time. But insularity kept out for long the more fertile calculus of Leibnitz from the home of Newton. It was not till 1812 that the sterile calculus of fluxions was deposited in the museum. In that year the Analytical Society of Cambridge was founded to adopt Leibnitz in place of Newton; or as Babbage, one of its founders, put it, "To promote the principles of pure *D*-ism in opposition to the *Dot*-age of the University". Non-mathematical readers can see the pun if they are told that the notation for the differential coefficient of x was $\dot{x}$ (x dot) in Newtonian calculus and Dx (Dee x) in Leibnitzian calculus.

Newton's Approach

Thus Newton's approach to mathematics was from the side of physics and the phenomena of the material universe and for the purpose of employing it as a tool. Concrete phenomena are ever so complex and there is no end to the variety of tools which they call for. Even to-day mathematics is being enriched by new tools demanded by newly discovered phenomena in physics; witness the calculus of operations, the calculus of tensors and the theory of Wave Function. Green, Kelvin and Poincare are some of the later mathematicians who enriched mathematics in this way. The Indian mathematicians of the Vedic age had enriched geometry similarly, i.e., by the urge to solve a concrete problem.

Ramanujan's Approach

But Ramanujan's approach to mathematics was from another side, the side of form—its beauty and potency. Euler, Galois and Riemann had done so before. The Greek mathematicians of the classic age had enriched geometry similarly. We saw that Newton's boyhood-experience registered with his mode of approach to Mathematics. It was so with Ramanujan too. His boyhood was spent in making patterns of magic squares, playing with the formulæ enumerated in Carr's *Synopsis* and listening to *puranic* discourses on the infinite attributes of God. Two intimate friends who were with him virtually all through, except during his sojourn in England, assure me that his sensitiveness to form was unusual and that, as they could not follow mathematics, he used to entertain them till late in the night with interpretations of the *Ramayana* and the *Mahabharata* based on certain patterns of thought which were exquisitely beautiful and the mathematical correlates of which he would occasionally indulge in expounding.

Force of Form

Hardy's reminiscence about the taxi-cab No. 1729 is significant. Hardy's remark that it was 'dull' elicited a prompt reply from Ramanujan: "No, it is a very interesting number; it is the smallest number expressible as a sum of two cubes in two ways." Hardy asked for the corresponding number for fourth powers and Ramanujan replied, after a moment's thought, that the first such number must be very large. The fascination and force of form may be traced behind most of Ramanujan's work on the theory of numbers and of modular functions. We witnessed a pretty manifestation of the same in a mathematical social evening at Madras in 1914 in which Ramanujan pierced, as it were, through the traditional integer-garb of the Leibnitzian form for the differential coefficient of the nth order and utilising the Eulerian generalisation of the factorial into the gamma function entertained the audience with the beauty of fractional differentiation.

Complementary Approaches

Both the approaches are necessary to disclose the potency of mathematics. But the illumination from Ramanujan's side of approach is more subtle and visible only to a select few; while that from Newton's side is more extensive and lights up many a path in many a field of knowledge.

CENTENARIES

An account of Sir Isaac Newton is given elsewhere in this issue.

Scheele, Carl Wilhelm (1742-1786)

CARL WILHELM SCHEELE, a Swedish chemist, was born at Stralaund, 19 December 1742. He was sent to college, but showing no talent for languages, was pronounced a dunce and was apprenticed to an apothecary. Here he studied the then known works in chemistry in spare moments and experimented secretly in the night-time. He served successively in some of the private pharmacies at Malmo, Stockholm, and Upsala. His employer at the latter place was curious to know why saltpetre, after being heated to a certain temperature and allowed to cool, gives off red fumes on being mixed with vinegar and asked a student studying chemistry about it; but he could not explain nor could Bergmann his professor. But later, Scheele told his employer that it was due to two acids. nitrous and nitric being there, the latter of which was expelled in the form of red fumes. This incident secured for Scheele the friendship of the professor and through it the patronage of the court and the public.

Scheele's record as a discoverer is probably unequalled, in spite of his poverty and poor laboratory facilities. He discovered the tartaric, fluosilicic, arsenic, uric, lactic, oxalic, gallic and several other acids. He discovered chlorine. He was the first to distinguish silica from alumina. He ascertained the nature of graphite. He found the composition of prussic acid and obtained glycerine. His only book *Aire and fire* recorded the observation made in 1773 that the atmosphere is composed of two gases—oxygen and nitrogen. As the book was published only in 1777, the priority of discovery went to Priestly, who announced his discovery earlier in 1774.

Scheele received from many quarters evidence of the high esteem in which he was held. He was offered professorships in several countries. But he preferred to work in his own private laboratory. When he got one, "Oh, how happy I am!", he wrote to a friend, "No care for eating or drinking or dwelling, no care for my pharmaceutical business, for this is mere play to me. But to watch new phenomena this is all my care, and glad is the enquirer whose discovery rewards his diligence; then his heart rejoices." His discovery of the means of producing Prussian Blue immortalised his name in the words "Scheele's green".

Scheele died 26 May 1786.

S. R. RANGANATHAN.
University Library,
Madras.

"Nature and nature's laws lay hid in the night
God said, 'Let Newton be' and all was light."

ALEXANDER POPE.

"It did not last; the Devil howling 'Ho
Let Einstein be' and restored the *status quo*."

J. C. SQUIRE.

SCIENCE NOTES AND NEWS

Electrical Properties of Beidellite Membranes.—Investigations on the electrochemical properties of clay membranes by Marshall and Krinbill (*J. Amer. Chem. Soc.*, 1942, **64**, 1814) have resulted in the preparation of an improved type of clay membrane (Beidellite membrane) which has got several advantages over the Montmorillonite membrane which was being used on previous occasions. The beidellite membranes attain equilibrium with fresh solutions much more quickly, the initial asymmetry potentials disappear more rapidly on soaking and the individual differences between membranes are very much smaller. Added to this the new membrane can be used in the potentiometric estimations of both mono and bivalent cations while the montmorillonite membrane can be used only in the estimation of monovalent ions. The effect of temperature of baking on the nature of the membrane is also investigated, using different sodium salts. When the beidellite membranes are employed in the potentiometric determination of sodium in different sodium salts, excellent reproducibility is noticed. The potentials obtained with solutions less concentrated than 0·03 N are within 1 millivolt of those calculated using the Nernst equation. Sodium chloride, sulphate and ferrocyanide give practically the theoretical potentials while the citrate gives low values probably due to complex formation. The experimental determination of the mobility of different cations within the clay membranes can enable one to predict the theoretical potentials for mixtures of cations. M. R. A.

Nutritive Value of Yeast Protein.—Most of the protein requirement of man is obtained through cereals. But the proteins of the cereals, as a class are not nutritionally of the highest quality, since many do not contain a sufficient proportion of certain of the dietetically essential animo-acids. For a healthy diet, the ordinary cereal diet should be supplemented by other protein-containing foodstuffs. T. F. Macrae, M. M. El-Sadr and K. C. Sellers have published (*Bio. J.*, 1942, **36**, 460) some very

interesting results on the value of yeast proteins as a supplement to a maize diet. Pigs do not thrive either on mere maize diet or even when supplemented with lysine or tryptophane, unlike the case of rats. Since the vitaminic extracts of yeast could not supplement the maize diet, the inadequacy of the maize proteins is obvious. The addition of 5 per cent. yeast (2·5 per cent. crude protein) to the maize diet change it from one unsuited for the rearing of pigs to one which yields fine animals. Yeast protein is not inferior to casein for this purpose. It is suggested that since high quality proteins and vitamins of the B-complex are the principal nutrient factors lacking in many poor diets, yeast which contains about 50 per cent. of high quality proteins and quantities of B-complex vitamins unsurpassed by any natural product, would correct the deficiencies of such diets more effectively than other foodstuffs. V. S. G.

Inflation of Shellac Prices.—As there has been a tendency for marked increase in prices of shellac in these two years, the Indian Lac Research Institute, in a press note, has drawn attention to the need for keeping the prices of shellac at a moderate level so that it may not lose its export market in the long run by the development of cheaper synthetic resins abroad. The dealers in shellac are advised to maintain the price of T.N. shellac between Rs. 50 and Rs. 60 per maund to prevent such a catastrophe. If a boom in prices is necessitated by supplies falling short of demand, the Indian Lac Research Institute, it is stated, would assist in augmenting the yield by demonstration and advice regarding improved methods of cultivation. It is hoped that those interested in the lac industry would avail themselves of the help offered by the Lac Research Institute and see to it that the demand for shellac in the foreign market, which is its mainstay, is not jeopardised by an undue inflation in prices. A. V. S.

Flora of the Bailadila Range.—Since the publication of "A Sketch of the Flora of the Bailadila Range in Bastar State" (Mooney, H. F., *Indian Forest Records*, N.S., 3, No. 7, 1942), the concerned region has become a place of much interest, especially from the point of view of Plant Geography. Bailadila Range forms an isolated unit by itself topographically as well as floristically; it is situated midway between the vast forest regions of the Northern and Southern India, at the same time being separated from them by wide gaps devoid of any important hill ranges; it mingles in its floristic wealth a number of species that show a Northerly affinity of distribution, those that show an Easterly affinity, those with Southerly affinity and those with Westerly affinity. The ecological formation of plant-associations have been dealt with at considerable length. Finally the author postulates the different possible modes of the transmigration of the plants from the southern and northern forest belts to this particular Range. B. G. L. S.

Antagonism between Strains of Mosaic.—Cases of definite antagonism between different strains of the peach-mosaic virus have been recorded in Colarado, U.S.A. (Bodine, E. W., *Phytopathology*, 1942). Elberta peach, affected by the "slight strain" of the virus, when reinoculated with the "severe strain" showed only symptoms of the former. That the mosaic of the "severe strain" was introduced into the plant tissue was insured in the control inoculations. The buds of the reinoculated tree were removed and inserted to healthy trees. The healthy trees thus inoculated developed symptoms of only the "slight strain" and indicated the complete inhibition of the "severe strain". M. J. T.

Factors affecting the Longevity of Cotton Seeds.—How long and under what conditions can cotton seeds be kept in storage without detriment to the germinating capacity? This question interesting to the farmer and trader alike is answered in a series of studies which have been going on for over ten years and the results of which are now published (D. M. Simson, *Jour. of Agri. Res.*, **64**, No. 7). The studies were made with the seeds of American Upland and Sea-Island varieties. The moisture content of the seed has been found to be the factor of the greatest importance. Seeds stored in ordinary gunny bags soon attain an equilibrium with the moisture content of the environment, approximately 11 per cent. In two years such seeds deteriorated rapidly and in three years were all dead. In contrast, sun-dried seeds with approximately 8 per cent. moisture when stored in ordinary containers retain their viability for quite seven years and a few of them were still able to germinate even after ten years. If the moisture content does not go above 8 per cent. seeds can be kept even in air-tight containers; aeration does not seem to be necessary. Temperature is the second important factor, and three levels were compared, *viz.*, 90°, 70° and 33°, with moisture levels varying from 7 to 14 per cent. With the higher moisture content storage at 90° killed all the seeds in 4 months, and after 36 months only those with 7 per cent. moisture were unimpaired. In contrast, at 33° even the seeds with 14 per cent. moisture retained their vitality for 36 months. The 70° storage was intermediate with respect to moisture tolerance. Analysis showed that the deterioration is accompanied by an increase in the percentage of free fatty acids in the oil. A. K. Y.

Department of Chemical Technology, Bombay.—According to the Annual Report for 1941-42, the Department has been enriched by an endowment of Rs. 2 lakhs from the Sir Dorabji Tata Trust for the creation of a Readership to be named after Sir Dorabji Tata for the Pharmaceutical and Fine Chemicals Section. It is probable that admission to this course will be made in June 1943. It is satisfactory to note that the research activities of the Department have continued to expand and several new schemes have been undertaken on behalf of industry and subsidised by industrialists, industrial organisations, and

Government Departments. Particular attention may be drawn to the important series of investigations on chemicals and dyes needed in textile processing. It is interesting to note also that during the year, owing to the shortage or non-availability of standard proprietary products due to the war, numerous substitutes offered in their place were received for tests and that several of the wetting agents, desizing agents, textile antiseptics and mildewed fabrics were tested by methods evolved or standardised by the research workers of the Department.

Administration Report of the Government Mineralogist for 1941, Ceylon, Part II—Revenue (1).—This report which covers ten pages, describes the nature of the routine activities as well as of the special studies during the period. Regular geological survey work has provided additional information on the geological history of the island.

Two investigations of economic importance deserve special mention. These relate to the utilisation of (1) a fairly large peat deposit and (2) the vanadium content of ilmenite segregation bodies occurring in some parts of the island. K. R. K.

Illustrating the Technical Lecture.—According to H. E. Dance (*Engineering*, July 3, 1942, page 15), good lantern slides can be made from typescript, if the imprint has been made with ordinary thin black carbon paper, instead of a ribbon. Notes and sketches can also be typed directly on cellophane, by placing the cellophane in a folded carbon paper so that the working surface of the carbon is applied to both faces of the cellophane. The matter is then typed without using the carbon. Cellophane slides need not be bound. The lettering does not rub off, and they are much more convenient to store when they are without glass covers. For projection they may be placed between two cover-glasses which have a tape or paper hinge down one edge, forming a temporary slide from which the cellophane slip is removed as soon as projection is finished. Half-a-dozen of such open "glass sandwiches" will meet the needs of most lectures. On page 54 (July 17, 1942) of same Journal, R. Fairthorne points out that cellophane can be sensitised with blue print solutions in much the same way as paper, and will give good results with half-tone negatives as well as line. For slides of more pleasing colour and greater permanence, any of the "ferri-to-ferro" processes can be used.

Timber for Aircraft.—Wood of the aircraft quality needs to have a high strength to weight ratio. The proper selection, conversion and seasoning of the timber is a matter of high technique. Experiments have proved the suitability of Himalayan fir and spruce and operations for extracting these woods on a commercial scale have already started. Possibilities of extracting champ and bonsum from the Assam woods are now under investigation. The Kulu Division in the Punjab, the Teri-Garhwal State and the forests of Assam are three locations from where it is expected to obtain these special quality woods. In regard to various other supplies for Defence purposes, the timber resources of India last year met demands through the Department of Supply to the total of 396,000 tons and demands placed on the Department in the current year are expected to reach a total of over one million tons. India's sawmill equipment will be enriched by additional machinery which she will receive under Lease-Lend from America.

Industrial Research Institute.—According to *Science* (1942, 95, 571), the Industrial Research Institute, which is an affiliate of the National Research Council, undertakes to promote improvement of methods and more economical and effective management of industrial research through the co-operative efforts of its members. The membership is composed of 45 industrial concerns maintaining research laboratories. Their chief executives in charge of research represent them in the activities of the Institute which has its headquarters in Chicago.

At the fourth annual meeting held at Cleveland on May 22 and 23, round-table discussions were held which dealt chiefly with the adjustment of research programmes and personnel to meet war conditions.

According to *Nature* (September 19, 1942) among a number of Soviet scientific films exhibited at the Imperial Institute Cinema, London, on September 12, the one on "Experiments on the Revival of Organisms" was undoubtedly the most impressive. After a brief and exceptionally clear pictorial explanation of the function of the heart and lungs the film lead up from the artificial setting in motion of an individual organ, the heart, to the revival of a dog's severed head and finally to the revival of animal itself, from which the blood had been completely drained off and the heart-beats and respiration of which had ceased for ten minutes. The blood was recirculated by means of an artificial circulatory system, the "autojector", the deceased animal heaved its first sigh, heart-beat and respiration began to register, and, after a short time, the autojector was disconnected and life proceeded. Within a few days the dog was its normal self again and, as the film showed, "lived happily ever after". The producers are to be congratulated on the skill and beauty of this film, which, while maintaining full scientific clarity throughout, nowhere offended the æsthetic senses, opened up an unlimited perspective of scientific advance and could not fail to instil into the most unimaginative minds a profound respect for scientific effort and achievement. The commentary to the films was prepared by Prof. J. B. S. Haldane.

Wartime Sources of Vegetable Rubber in India.—In the Indian Forest Leaflet No. 22 (Silviculture), Mr. T. V. Dent considers the formation of emergency plantations for wartime supplies as useless, since no plantation will yield an appreciable return of harvested rubber in less than four years from its establishment. Under conditions of forced cultivation only the para (*Hevea braziliensis*,

Euphrobiaceæ) or Ceara (*Manihot glaziovii* Euphorbiaceæ) might be able to give a worthwhile return in about four years.

Attention can, therefore, be paid to wild rubber-yielding plants. About 17 of them are reviewed and it is surmised that, if the collection is subsidised, wild *Ficus elastica* from Assam, Bengal, Sikkim and Bhuthan may yield several hundred tons of raw rubber annually.

In addition to the immediate application of intensive methods of management to existing rubber plantations in South India, re-exploitation of the existing old and abandoned plantations of *Ficus elastica* from Assam and Bengal alone, may be expected to contribute addditional 30 to 40 tons annually.

Detection of Cracks in Engineering Materials.—Fluorescent light has been effectively pressed into service for the detection of flaws or cracks in engineering materials by The Colloidal Research Laboratories, London, in their "Glo-Crack" system. The articles to be examined are first immersed for a short period in a hot bath of fluorescent material. They are then transferred to a second bath containing a solution which removes all the fluorescent material except that which is entrapped in any flaws or cracks. After this, each article is examined under ultra-violet light and every small flaw or crack glows with the characteristic colour while the remainder of the specimen remains dark. In this way a crack, no matter how fine, can scarcely escape detection, and this is attained without severe eye-strain or mental fatigue on the operator. Other advantages are its applicability, without staining or the necessity for after-treatment, to all metals and to many other materials, its simplicity and cheapness of operation, and the quickness with which the process can be carried out, even on mass-produced articles (*Nature*, September 19, 1942, p. 343).

Industrial Research Fund.—The Government of India have decided that a Fund, *viz.*, Indian Research Fund, should be constituted by grants from the Central Revenue to which additions are to be made from time to time from other sources. A provision has been made in the Central Budget for an annual grant of 10 lakhs of rupees to this fund for a period of 5 years and, the other sources will comprise grants, if any, by Provincial Governments, by industrialists for special or general purposes, contributions from Universities and Local bodies, donations, benefactions, royalties, etc. The Council of Scientific and Industrial Research which has now been established on a permanent basis, with the Member of the Council of His Excellency the Governor-General in charge of the portfolio of Commerce as *ex-officio* President, will exercise full powers in regard to expenditures towards (*a*) the promotion, guidance and co-ordination of scientific and industrial research in India including the institution and the financing of specific researches; (*b*) the establishment or development and assistance to special institutions or departments of existing institutions for scientific study of problems affecting particular industries and trade; (*c*) the establishment and award of research studentships and fellowships; (*d*) the utilisation of the results of the researches conducted under the auspices of the Council towards the development of industries in the country and the payment of a share of royalties arising out of the development of the results of researches to those who are considered as having contributed towards the pursuit of such researches; (*e*) the establishment, maintenance and management of laboratories, workshops, institutes, and organisations to further scientific and industrial research and to utilize and exploit for purposes of experiment or otherwise any discovery or invention likely to be of use to Indian industries; (*f*) the collection and dissemination of information in regard not only to research but to industrial matters generally; and (*g*) publication of scientific papers and a Journal of industrial research and development. The Council will co-ordinate and generally exercise administrative control over the work of the Board of Scientific and Industrial Research and Industrial Research Utilisation Committee.

The Application of Nitrogenous Manures to Cotton.—Remarkably high yields of cotton have been reported as the result of applying sulphate of ammonia as manure for the cotton crop according to a special method (R. J. Kalamkar in *Nagpur Agr. Coll. Mag.*, 16, No. 4). The method consists in coating the cotton seed prior to sowing with dry sulphate of ammonia powder, the seed itself being moist with the wet paste of earth and cowdung which is usually rubbed over it to paste down the fuzz and make the seed run freely through the drill. This method was compared with (1) applying the same dose of sulphate of ammonia as a top-dressing three weeks after sowing and (2) applying one half the dose by drilling it with the seed at sowing time and the other half as a top-dressing three weeks after sowing and (3) control. The seed rate per acre was 20 lb. and the sulphate of ammonia used was at the rate of 10 lb. of nitrogen or the equivalent 50 lb. of ammonium sulphate per acre. The trials were conducted at the Government Seed and Demonstration Farm at Khandwa and the variety of cotton was V. 434. The experimental plots were laid out in a randomised block with five replications. The results show that a very high and significant increase in yield was obtained by the method of coating the seed with the fertiliser and that this increase in yield amounted to 66 per cent. over the control. The other two methods also gave increased yields of 14 to 18 per cent., but these increases were not statistically significant.

A. K. Y.

Suitability of Indian Woods for Battery Separators.—The essential characteristics of a wood for battery separators are good permeability, freedom for volatile acids, a low percentage of resinous matter, sufficient mechanical strength, good machining qualities, and resistance to the action of the electrolyte. The quantity of tannins and other colouring matter should also be reasonably small, so that they can be removed by a short-period chemical

treatment. The finished separator should be straight-grained and free of seasoning defects such as cracks and shakes. The Forest Research Institute, Dehra Dun, as a result of the detailed investigation into the matter, considered the following woods as possibilities for the purpose of manufacturing battery separators from the standpoint of their anatomical structure and physical properties: (1) *Adina cordifolia* (haldu), (2) *Cupressus torulosa* (cypress), (3) *Michelia champaca* (champak) and (4) *Talauma phellocarpa*.

The timber is converted into planks, which are air-seasoned before manufacture into battery separators. The separators, after manufacture, are given a chemical treatment to remove all the volatile acids, and to get rid of tannins and resinous matter. (See also the Indian Forest Leaflet No. 14, 1942. Price As. 4 or 6*d*.)

The results so far obtained show that there is practically no difference in the behaviour of cells fitted with the above Indian woods and Port Orford cedar (*Chamæcyparis lawsoniana*), an American wood, which till recently was the most commonly used wood for this purpose.

The Ripening Coconut.—Studies on the growth of the ripening coconut and principally with reference to the changes undergone by the fibre throw interesting light on the formation and the progressive changes in composition of the other important and really the main coconut product, the kernal itself (S. R. K. Menon, *Ind. Jour. of Agr. Sci.*, 12, Part III). The method of study consisted in selecting one particular bunch on a tree and following the changes from the very infancy of the fruit to its ripe stage, three such trees being selected for the purpose of confirmatory results. The results confirm the correctness and the wisdom of the present practice of gathering only coconuts which are not fully ripe when fibre production is an important objective. Where oil is the important consideration the nuts have to be gathered at a much later stage, so that the interests of the oil and coir industries are opposed to each other. Taking the particular points studied, it is seen that as regards the volume of the fruit and the weight, the increases are equal during the first six months and then the rate for the volume becomes slow and later begins to diminish. On the other hand, weight begins to drop sharply after the same period until it is only one half of the maximum reached. The water in the nut increases rapidly and reaches a maximum in about three months, after which it declines steadily and sharply until it is only about a seventh part of the maximum, in the tenth month. As regards the kernal it begins to form only after the first three or four months but once begun the growth is very quick, reaching a maximum in the ninth or tenth month, after which the change consists only in an increase of density, when the formation of fat becomes vigorous. Ultimately the moisture content falls and the gross weight also registers a decline; the fat content is said to go on increasing to the last days of the growth of the fruit. The fibre as it matures increases in lignin and loses both colour and gloss practically until the very last stages of growth; the non-lignin content increased up to the sixth month steadily, but became more or less stationary thereafter. The picking of the nut when not fully ripe therefore results in a fibre of high non-lignin content and a low-lignin content.

A. K. Y.

Wood Disc Dowel Joints in Timber Framed Structures.—In framed structures, properly designed joints are just as important as properly designed members, because the transmission of stress from one member to another depends upon the efficiency of the joints. In timber structures, it is difficult to make a satisfactory joint with bolts and rivets. A great variety of joint details are, therefore, in use. These usually require too much steel and labour, and are very costly.

The wood disc dowel joint requires very little steel; it is simple to make; it is very efficient and allows the use of planks instead of thick solid scantlings. A disc dowel is a circular wood disc, generally tapered each way from the middle so as to form a double conical frustrum. It is fitted into prebored holes half in one member, and half in the other. A bolt is used through the centre of the disc to keep the jointed wood members from spreading apart. The dowel can be made of any hard wood that seasons easily and keeps its shape well. *Babul, sissoo* and rosewood are suitable for making disc dowels. Other hard species can also be used, but many hard woods are difficult to season and liable to warp and split. Structural joints in timber frames, if made with wood disc dowels, reduce the cost of timber structures very substantially as has already been demonstrated. V. D. Limaye's leaflet on Wood Disc Dowel Joints in Timber Framed Structures (*Indian Forest Leaflet* No. 31), explains the function of the disc dowel, and shows how to make these typical structural joints in timber.

Post-War Indian Trade.—Addressing the All-India Manufacturers' Organisation in Bombay, Sir M. Visvesvaraya stressed the need to safeguard Indian trade and Indian interests in the post-war period. Proceeding he said that as soon as the war was over, India might again be exposed to the fury of an international economic war. To give the country adequate protection, it was necessary to appoint at once a representative central council of business men, experts and leaders in science and politics, to watch the trends and make preparations to meet all possible obstacles and opposition. It might be called a Development Board or an Economic Council, and might take the place of the Consultative Committee of Economists on Post-War Reconstruction, appointed by the former Commerce Member.

Explaining the objects of the Manufacturers' Organisation, the steps taken by the various belligerent countries in regard to post-war reconstruction, and conditions in India, Sir M. Visvesvaraya stated that there were now a number of Indians on Viceroy's Executive Council. Post-war reconstruction and industries were each of them important enough to require the whole-time services of a Member to itself. Nevertheless, both of them were left

with the Commerce Member, whose time was fully taken up with matters connected with the war emergency.

"The people are now faced", he said, "with a great struggle immediately the war ends, to render secure the future food supply and income of the nation. They can neglect this duty only at their peril. It has been said there will be war after war; economic war may follow military war, and expose the industries and trade of this country to severe international competition."

Referring to India's industrial development, he said that the developments recorded in Canada and Australia showed that this country had missed a great opportunity to build up its industries in the present war. "This was", he continued, "through lack of any policy in the Government of the country and lack of co-operation and interest on its part to benefit the Indian population".

National Institute of Sciences of India.—At a meeting of the Council's Committee of the National Institute of Sciences of India, held on the 11th December 1942, the following were duly elected as Ordinary Fellows of the Institute:—

Dr. J. C. Bardhan, D.Sc., Calcutta; Mr. R. C. Bose, M.A., Calcutta; Dr. N. C. Chatterjee, D.Sc., Dehra Dun; Mr. M. N. De, M.B., M.R.C.P., Calcutta; Dr. R. D. Desai, D.Sc., D.I.C., Bombay; Dr. B. N. Ghosh, D.Sc., Calcutta; Dr. C. S. Pichamuthu, Ph.D., Mysore; Mr. K. Ramiah, M.B.E., M.Sc., Dip.Agr., Indore; Prof. T. R. Seshadri, Ph.D., Guntur; Dr. S. C. Sirkar, D.Sc., Calcutta; Mr. V. V. Sohoni, M.Sc., New Delhi; Dr. N. R. Tawde, M.Sc., Ph.D., Bombay; Mr. E. T. Vachell, M.A., F.G.S., Digboi.

Nagpur University.—Dr. A. Nagaraja Rao, Professor of Applied Chemistry and Chemical Engineering in the Lakshminarayan Institute of Technology, has been appointed Chief Chemist, Tata Chemicals, Mithapur. In the vacancy caused by the resignation of Dr. Nagaraja Rao, Dr. P. S. Mene, M.Sc., Ph.D. (Lond.), of the C.P. Educational Service, has been appointed Reader in Applied Chemistry and Chemical Engineering.

MAGNETIC NOTES

Magnetic conditions during November 1942 were less disturbed than in the previous month. There were 17 *quiet* days and 13 days of *slight* disturbance as against 13 quiet days, 13 days of slight disturbance and 4 of moderate disturbance during the same month last year.

The quietest day during November 1942 was the 6th, while 24th was the day of the largest disturbance.

The individual days were classified as shown below:—

Quiet days	Disturbed days		
	Slight	Moderate	Great
3–7, 9, 11, 12, 14–19, 21, 22 30	1, 2, 8, 10, 13, 20, 23–29	Nil	Nil

There were no magnetic storms during the month of November 1942 while one moderate disturbance was recorded during November 1941.

The mean character figure for the month of November 1942 was 0·43 as against 0·70 for the same month last year.

A. S. CHAUBAL.

SEISMOLOGICAL NOTES

During the month of November 1942, seven slight, two moderate and one great earthquake shocks were recorded by the Colaba seismographs as against six slight, four moderate and three great ones during the same month in 1941. Details for November 1942 are given in the following table:—

Date	Intensity of shock	Time of origin I. S. T.		Epicentral distance from Bombay	Co-ordinate of the epicentres (tentative)	Depth of focus (tentative)	Remarks
		H.	M.	(Miles)		(Miles)	
7	Slight	14	02	3890	..	60	..
10	Great	18	11	8430	Lat. 48°S., Long. 27° E. near Marion Island.	..	..
15	Moderate	23	42	4230	..	..	..
17	Slight	03	56	1360	..	190	Epicentral region. In the Hindu Kush mountains. Reported felt at Peshawar and Lahore.
18	Slight	18	31	2230	..	..	..
20	Slight	19	48	1210	..	..	..
21	Slight	20	32	2720	..	..	..
25	Slight	09	26	1810	..	..	..
26	Slight	20	58	4530	..	..	Epicentral region. Off the west coast of Norway. Reported felt at Bergen and Sand (near Stavangar).
28	Moderate	17	09	7150	..	..	..

ANNOUNCEMENTS

Current Science and H. H. the Maharaja of Mysore

Readers of *Current Science* will be interested to learn that on the occasion of his recent visit to the Indian Institute of Science, on Tuesday, the 15th December 1942, His Highness the Maharaja of Mysore was graciously pleased to accept a few numbers of the current volume of the Journal, placed in a case bound in morocco leather, which was inscribed as follows:

Respectfully submitted to His Highness the Maharaja of Mysore, by Prof. J. C. Ghosh, President, The Current Science Association, Bangalore.

Annamalai University—*Endowment by H. H. the Maharaja of Travancore.*—On the occasion of the Twelfth Convocation of the Annamalai University, held on the 9th December 1942, the Vice-Chancellor announced that H.H. the Maharaja of Travancore who was invited to address the graduates of the year, had endowed one lakh of rupees to the University. The purpose of the endowment will be revealed later.

Indian Statistical Conference.—The sixth session of the Indian Statistical Conference, 1943, originally intended to be held in Lucknow in January 1943, will not take place in Lucknow. In order however to avoid a break in the continuity of the Conference, the Council of the Indian Statistical Institute has decided that a short session should be held in Calcutta and arrangements are being made accordingly. It is expected that the Conference would be opened on or about the 2nd January 1943. The exact date and detailed programme would be circulated as soon as possible.

Blood Banks—Errata.—We wish to invite the special attention of our readers to the *Errata* pertaining to the article on Blood Banks, published elsewhere in this issue.

According to *Nature* (October 10, 1942), Sir Henry Dale, President of the Royal Society, has accepted the Directorship of the Laboratories of the Royal Institution, London, with the Fullerian Professorship, in succession to the late Sir William Bragg.

We acknowledge with thanks receipt of the following:—

"Journal of the Royal Society of Arts," Vol. 90, Nos. 4620 and 4621.

"Journal of Agricultural Research," Vol. 64, No. 11; Vol. 65, No. 2.

"Indian Journal of Agricultural Science," Vol. 12, Pt. 4.

"Agricultural Gazette of New South Wales," Vol. 53, Nos. 8 and 9.

"Biochemical Journal," Vol. 36, Nos. 5 and 6.

"Chemical Products," Vol. 5, Nos. 9-10.

"Experiment Station Record," Vol. 87, No. 1.

"Indian Forester," Vol. 68, No. 12.

"Transactions of the Faraday Society," Vol. 38, Pt. 9.

"Indian Farming," Vol. 3, Nos. 10 and 11.

"Horticultural Abstracts," Vol. 12, No. 3.

"The Bulletin of the Indian Central Jute Committee," Vol. 5, No. 8.

"The Review of Applied Mycology," Vol. 21, No. 8.

"Nature," Vol. 150, Nos. 3801-3802.

"Journal of the Bombay Natural History Society," Vol. 43, No. 3.

"Canadian Journal of Research," Vol. 20, No. 8.

"Science and Culture," Vol. 8, No. 6.

"Journal of the Scientific and Industrial Research," Vol. 1, No. 1.

"Indian Trade Journal," Vol. 147, Nos. 1898-1903.

Books

Annual Review of Biochemistry, Vol. 11. Edited by James Murrey Luck. (Annual Reviews Inc., California), 1942. Pp. x + 736. Price $5.00.

Hydrogen Ions, Vol. I. Third Edition. (Edited by E. H. Tripp). By Hubert T. S. Britton. (Chapman and Hall, London), 1942. Pp. xx + 420. Price 36*sh.*

Hydrogen Ions, Vol. II. Third Edition. (Edited by E. H. Tripp). By Hubert T. S. Britton. (Chapman and Hall, London), 1942. Pp. xx + 443. Price 36*sh.*

Yantric Sodhanchya Naveenya Katha (in Marathi). By Kasinath Anantha Damle. (The Author, Kalabhavan, Baroda), 1940. Pp. 140. Price Rs. 1-8-0.

Modern Pottery Manufacture. By H. N. Bose. (Ceramic Publishing House, Bhagalpore), 1942. Pp. vi + 481. Price Rs. 6-8-0.

ERRATA

Vol. 11, *No.* 11, *November* 1942

Page 423, para 3, line 8, *for* "useful References", *read* "Useful References". Para 5, line 14, *for* "Universal", *read* "universal". Para 6, line 4, *for* "semisolid", *read* "semi-solid". Para 8, line 2, *for* "Air Raids", *read* "air raids".

Page 424, para 1, line 3, *for* "into recipient", *read* "into a recipient"; line 8, *for* "nitrate", *read* "chloride". Para 9, *for "fluid must"*, *read* "fluid must" (no italics). In the table, column 2, bottom, for "(= nothing small letter)", *read* "(= nothing, small letter)".

Page 425, in the List of Useful References, items (13) and (14), *delete* "(in press)", and *add* "1941".

Page 430, second column, line 1, *for* $K = (4{\cdot}68 \pm 5)$ *read* $K = 4{\cdot}68 \pm 0{\cdot}5$.

Page 438, second column, regarding magnification of the photomicrographs, *for* $\times 60$ *read* $\times 60$, reduced to ½.

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